THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 47 JUNE, 1942 No. 6

ROENTGEN MANIFESTATIONS OF ADULT TOXOPLASMOSIS*

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TOXOPLASMOSIS is a disease produced by *Toxoplasma*, a protozoan of uncertain taxonomic status, usually classed with the Sporozoa. Since 1908 it has been known to be pathogenic for animals,[17,24,26] but only recently has its pathogenicity for man been discovered. As first reported it was found in newborn infants suffering from a peculiar meningo-encephalitis.[20,22,27,29,30] Seven such cases of the infantile type of the disease have been reported. Recently 2 additional cases have been reported in children six and eight years of age.[23] This type takes on a form of meningo-encephalitis with retinitis and hydrocephalus as its outstanding manifestations. Cutaneous eruptions have been reported, but are not invariably present. There are no indications of lung involvement. It usually occurs in newborn infants, suggesting that the disease may be conveyed from infected blood of the mother.

Recently Pinkerton and Henderson[19] reported 2 proved cases of toxoplasmosis in adults. Clinically these have little if anything in common with the infantile form of the disease. Chills or chilly sensations followed by fever and symptoms of acute pneumonia were the most prominent manifestations in both cases. A general cutaneous eruption sparing only the palms of the hands, soles of the feet and scalp developed at the onset, but faded after a few days. In both cases there was a history of previous tick bite, suggesting the possibility of a rickettsial character of the disease. Clinically it may resemble Rocky Mountain spotted fever, and could easily be mistaken for it. The acute pneumonic involvement is the most outstanding characteristic of the disease.

As radiologists we are most concerned with the pulmonary lesions as manifested in the roentgenogram; upon the roentgenologist will undoubtedly fall the responsibility of recognition of many of these cases. We have here for consideration the chest roentgenograms of 2 patients reported by Pinkerton and Henderson.[19] The one, a female patient, seems to show the pulmonary manifestations at an earlier stage; the other, a male patient, was examined when the pulmonary manifestations were more fully established.

The earlier pulmonary manifestations may perhaps be best described as an appearance of acute pulmonary congestion with edema of the lungs; there is accentuation of the hilar shadows with an increase in the size and number of the

* Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

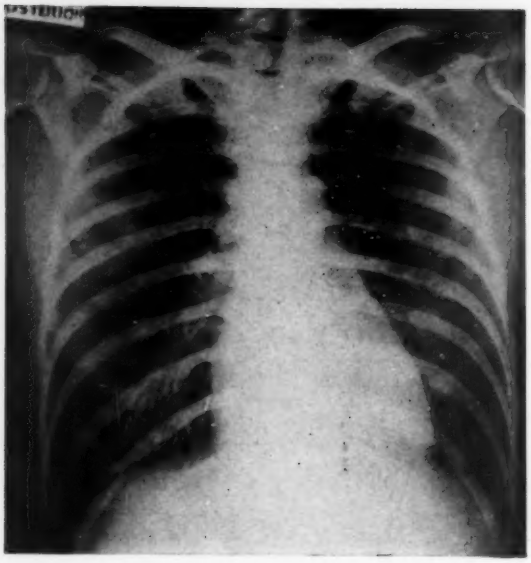

FIG. 1. Early manifestations of acute interstitial pneumonitis from toxoplasmic infection of the lung, as seen in the second adult case (female) reported by Pinkerton and Henderson.[19] At the onset there is a pronounced increase in the hilar shadows with accentuation of the lung markings radiating outward into both lungs. The peripheral lung markings assume the appearance of a network. The picture at this stage is very similar to acute pulmonary congestion with edema.

lung markings radiating outward from the hilar regions into both lungs but stopping short of the parenchymal structures. There is, in addition, the blotchy, blurred appearance seen in acute edema of the lungs. The picture, at this stage of the disease, is similar to that seen in passive congestion with pulmonary edema, but without cardiac enlargement. Any disease process of the lung which produces primary interstitial involvement may give a similar roentgen picture. For instance, aspiration of irritating material such as kerosene produces acute congestion from irritation followed by acute edema of the interstitial tissues. Aspiration of less irritating substances, such as water, in drowning, might be expected to cause a somewhat similar roentgen picture, but this changes rapidly. Perhaps the lesion which might most nearly simulate the lung condition, and therefore produce a similar roentgen picture, would be acute edema of the lungs from waterlogging caused by excessive forcing of fluids in postoperative cases.

At a more advanced stage of the disease the picture changes. The accentuated lung markings radiating outward into the lungs from the hilar regions are no longer the predominating features; they become overshadowed by the increasing interstitial infiltration and alveolar exudation. The composite picture is one of conglomerate areas of infiltration crowding upon each other to give the appearance of irregular blotchy consolidation of the lung. The site of greatest involvement seems to be the lower lobes. The roentgen picture at this stage, if considered without regard to the clinical manifestation, might be readily simulated by any of the atypical pneumonias, or by any of the mycotic infections. Extreme edema of the lungs from any other cause might be mistaken for this condition. Toxoplasmosis, however, is more acute and the symptoms are more grave. In both of the reported cases there was extreme prostration, high fever and intense cyanosis and dyspnea towards the end of the disease and the patients died from respiratory failure. Clinical symptoms would easily rule out *Toxoplasma* infection.

The pathology found at autopsy as reported by Pinkerton and Henderson,[19] explains very logically the roentgen findings. In the female patient four days after roentgen examination:

> All lobes of both lungs were edematous and consolidated, the right lung weighing 750 Gm. and the left 680 Gm. The cut surfaces of the lungs were grayish white, and when scraped with the knife, yielded a frothy, grayish white, semifluid material. . . .
>
> *Microscopic Examination.*—The lungs showed a remarkable picture of interstitial pneumonitis, with interstitial organization in many areas. Practically every alveolus appeared to be lined with cuboidal epithelium. . . . The alveoli contained a gelatinous appearing exudate in which very few inflammatory cells were present, and the alveolar walls were often lined with a thick, hyaline membrane similar to that seen in influenzal pneumonia. The heart showed

rare necrotic muscle fibers with relatively little cellular reaction. The liver and spleen showed occasional areas of focal necrosis like those seen in case 1. Toxoplasma was not numerous in any of the tissues. Occasional alveolar lining cells, as well as macrophages lying free in the alveoli and bronchioles, were distended with these organisms, and a few myocardial fibers, otherwise normal in appearance, contained large colonies of organisms. These parasitized muscle fibers were so few in number that it was impossible to find them in many of the sections of the myocardium. Toxoplasma was also found in the hepatic and splenic lesions.

As reported by Pinkerton and Henderson[19] in the male patient at autopsy seven days after roentgen examination:

The lungs were markedly congested, and a hemorrhagic, frothy fluid exuded from the cut surfaces. Uniformly distributed through all lobes of both lungs were firm, shotlike areas of induration, ranging from 1 to 3 or 4 mm. in diameter.

Microscopic Examination.—The lungs showed an interstitial pneumonitis, with rounding up of the alveolar lining cells, and areas of organization by connective tissue corresponding to the shotty nodules described grossly. In some areas there was also a fibrinopurulent exudate in the bronchioles and alveoli, but the connective tissue proliferation was in the alveolar walls rather than in the alveoli. The heart showed prominent fusiform accumulations of mononuclear cells between apparently undamaged muscle fibers. The liver and spleen, in addition to the characteristic changes of portal cirrhosis, showed scattered small areas of focal necrosis consistent with those described in previously reported cases of toxoplasmosis.

The most important microscopic feature was the presence in the tissues of intracellular protozoa having the morphologic characteristics of Toxoplasma. . . .

Essentially then, the process seems to be an acute interstitial pneumonitis with associated pulmonary congestion and edema. The gelatinous appearing exudate almost devoid of inflammatory cells, the cuboidal alveolar epithelium, the thick hyaline membrane lining the alveoli, all are manifestations of what is found in influenzal or virus pneumonia. Early in the influenza epidemic of 1918, such pathological characteristics were established as peculiar to the disease; the subsequent manifestations of infection with other bacteria such as the streptococcus merely added their reactions to the pathological picture. Since that time sporadic cases have occurred giving a similar picture which we have been satisfied to group under the heading of atypical pneumonias. There is no doubt that there are probably many types of pulmonary infection included in this group of atypical pneumonias. In addition to the unusual manifestations of bacterial infection, there are many in which no bacterial cause can be found. If, in addition, it is found on pathological examination that there is an interstitial pneumonitis with thickening of the alveolar wall, gelatinous non-cellular exudate in the alveoli, and formation of a hyaline mem-

Fig. 2. Later stage of acute interstitial pneumonitis from toxoplasmic infection of the lung as seen in the first adult case (male) reported by Pinkerton and Henderson.[19] As the disease progresses the accentuated hilar shadows and increased lung markings radiating from the hilum no longer present the most prominent roentgen feature. They become overshadowed by the blotchy peribronchial infiltration and the irregular alveolar exudation which gives the appearance of bronchopneumonia. The extreme periphery of the lung is last to become involved. At this stage the appearance is indistinguishable from atypical bronchopneumonia from any other cause.

brane in the alveoli, the condition is classified at once as virus pneumonia. Now it appears that even infections with this pathological finding may be caused by widely varying agencies.

A number of other types of lung involvement have been described which present this essential pathological picture. Psittacosis, a disease caused by contact with infected parrots, is generally accepted as a virus disease.[10] It takes on the form of an pneumonic process. Hoge[12] describes the pathology of psittacosis as follows:

> On gross examination it was seen that the consolidation was central in type and did not extend to the pleura, there being a layer of crepitant tissue surrounding each consolidated area. On cut section, the consolidated area was grayish-red in color and exuded a mucopurulent material on slight pressure. It was further observed that the consolidated areas did not show the firm consistency of ordinary pneumonia, but that sections cut from consolidated areas floated on water.
>
> The virus of psittacosis was obtained by inoculation of emulsions of both lung and spleen tissues into white mice.

Microscopically it shows the interstitial pneumonitis, gelatinous non-cellular alveolar exudate, hyaline membrane, etc. No organisms of any kind have ever been found. Roentgenographically the picture is similar to that produced by toxoplasmosis. It is possible that psittacosis may not be so rare; not only parrots, but other birds may also be carriers.

Another disease which has been described giving a similar roentgen picture is American Q fever.[4–8,11,13,18] This is a new rickettsial disease caused by *Rickettsia diaporica*, transmitted by a tick bite which was reported by Davis and Cox[7] in 1938. The filter passing agent was transmitted by tick bite to a laboratory worker. In 1940 Hornibrook and Nelson[13] described an epidemic of pneumonitis due to American Q fever. The chief feature of the disease was an acute, very virulent involvement of the lungs. The pathology was described as "Central pneumonia which would have been unrecognized in the absence of roentgen examination of the chest." It is possible that American Q fever likewise may not be so uncommon.

Still another type of virus has been recently isolated by intranasal inoculation of mice by Eaton, Beck and Pearson.[9] They state that:

> The recovered virus is practically identical with the virus of meningopneumonitis as described by Francis and Magill in 1936.
>
> The new virus differs from the commonly described strains of psittacosis in its failure to cause death of mice with hepatic necrosis after the repeated intraperitoneal passage.

In November, 1940, Weir and Horsfall[28] reported the isolation of a virus from an atypical pneumonia by injection of some of the sputum into the mongoose. This probably represents another type of virus infection.

Within the last few years numerous instances of similar atypical pneumonic infections have been published.[1,2,3,14,16,21,25]

Recently under the heading of "Bronchopneumonia of unknown etiology (variety X)", Longcope[15] reported numerous instances of unusual pneumonic involvement having somewhat similar characteristics.

The recent discovery by Pinkerton and Henderson, of toxoplasmosis as a new form of pulmonary infection producing a pathological picture practically identical with that seen in virus infection, in which definite protozoa can be demonstrated, would seem to reopen the entire question of atypical pneumonias.

It might be better, therefore, to follow the suggestion of Longcope, referring to all atypical pneumonic processes as, "bronchopneumonia of unknown etiology (variety X)," until a more conclusive method of differentiation is effected.

If we as roentgenologists are able, by careful consideration of the roentgen findings, to suggest the possibility of one of these unusual agents as the cause of the infection, we may aid materially in the investigation of this extremely important subject.*

* For discussion see page 841.

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TOXOPLASMIC ENCEPHALOMYELITIS

VIII. SIGNIFICANCE OF ROENTGENOGRAPHIC FINDINGS IN THE DIAGNOSIS OF INFANTILE OR CONGENITAL TOXOPLASMOSIS*†

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TOXOPLASMA is a protozoan parasite of uncertain classification which has been known since 1908 when it was reported independently by Nicolle and Manceaux in the North African rodent, the gondi, and by Splendore in the Brazilian rabbit. This protozoan infects many tissues, the central nervous system often being involved. It has been identified in many countries and found in many animal hosts, among which rodents and birds are especially prominent. In smears the parasites appear as well outlined, crescentic or curved masses of protoplasm, 4 to 6 micra in length and 2 to 3 micra in width. The ends are frequently pointed. When seen in sections of fixed tissues, rounded or oval types are the usual forms (Fig. 1). Under these conditions, the organisms appear smaller, measuring 2 to 3 × 1.5 micra. A rounded chromatin mass is found in the center or at one end of the parasite. The protozoa also occur as large, rounded masses of closely approximated organisms, sometimes referred to as cysts. Reproduction is by simple binary fission. By some it is claimed that schizogony occurs.

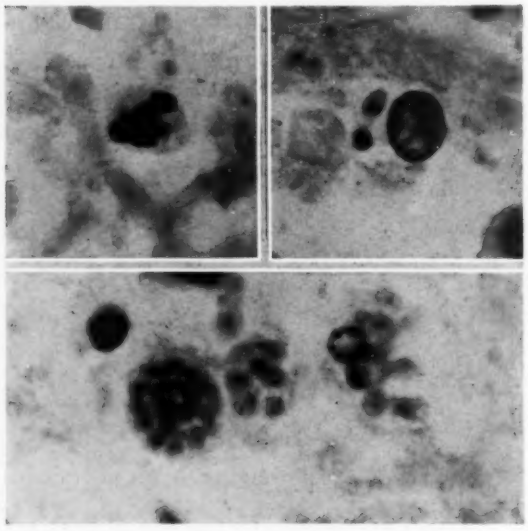

FIG. 1. Toxoplasmic encephalomyelitis. Single toxoplasmata in cells and extracellular clusters or "cysts" in necrotizing and inflammatory lesions in the central nervous system and retina.

Human toxoplasmosis was first encountered as an encephalomyelitis in infants. In 1937, Wolf and Cowen[14] described a form of infantile encephalomyelitis produced by a protozoan, and in 1939, Wolf, Cowen and Paige[16,17,18] proved it to be a toxoplasmic infection by transmission of the disease to animals from a subsequent case. Additional cases were later added by these authors and demonstrated to be instances of the same disease by the pathological findings, and again in one instance, by animal transmission.[8] Certain cases of central nervous system infection in infants which had appeared in the earlier literature[6,11,13] could by cross comparison, and in some cases by re-examination of the pathologic material, be identified by these same authors as additional examples of the disease.[15,16,17] Subsequently, *Toxoplasma* was found by Sabin[12] to produce an encephalomyelitis in older children, and by Pinkerton and Weinman[10] and by Pinkerton and Henderson[9] to give rise to a generalized infection in adults, often predominantly pulmonary.

Infantile toxoplasmic encephalomyelitis

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† Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

occurs in young infants of either sex who show symptoms and signs soon after birth or are born with hydrocephalus. They may have convulsive seizures, progressive enlargement of the head, increased intracranial pressure, microphthalmos and manifestations of involvement of many areas of the nervous system. Focal chorioretinitis, a striking feature of the disease,[7] occurs in both eyes, frequently in the macular region, and appears as yellowish-white or brownish-red, round or oval, slightly depressed or elevated patches which show irregular central or marginal dark pigmentation. The spinal fluid is xanthochromic, contains a large amount of protein and shows a pleocytosis, chiefly of round cells. Some of the patients die during the first months of life, while others survive with ocular and cerebral defects.[2] Pathologically, these cases show a widespread encephalomyelitis marked by focal inflammation and necrosis and an accompanying localized leptomeningitis. In later stages, these necrotizing lesions show a marked tendency to calcify[17] (Fig. 2). Miliary granulomata, composed of epithelioid cells without necrosis or giant cells, are scattered throughout the central nervous system and are a characteristic feature of the disease (Fig. 3). Focal inflammatory and necrotizing lesions are also found in the retina and choroid and may occasionally occur in other organs.

The reservoir of animal toxoplasmosis in rodents and birds referred to above may be

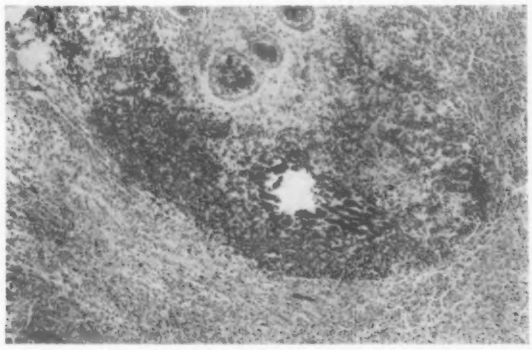

Fig. 2. Toxoplasmic encephalomyelitis. Calcification in degenerated cerebral cortex.

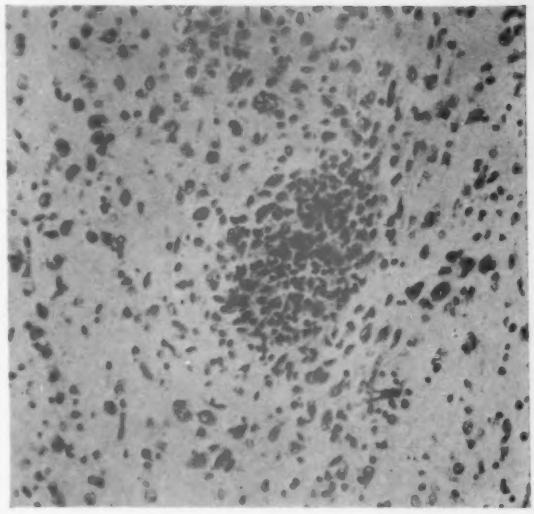

Fig. 3. Toxoplasmic encephalomyelitis. Typical granuloma in cerebrum.

the source of human infection. The natural mode of transmission is at present unknown. The possibility of the mediation of an insect vector has been raised, but no proof adduced for it. In the infantile form of toxoplasmosis under discussion, the inception of the disease *in utero* has been established in some instances.[19]

ROENTGENOLOGIC ASPECTS

Cerebral calcification and internal hydrocephalus had been noted as prominent features of infantile or congenital toxoplasmic encephalomyelitis at necropsy,[8,15,17] which suggested that their identification by roentgen examination might be helpful in clinical diagnosis.[8,17] This has proved to be the case.

Ten cases of this disease were examined roentgenographically. These included 4 cases which were not recognized until necropsy (J.S.,[14] C.D.,[17] L.M.,[8] and A.M.T.[8]) and 6 cases that were diagnosed clinically (Cases P.D.,[2] J.F.,[2] A.I.,[2] M.B.,[2] D.H.,[2] and C.J.[2]). Details of the findings in these cases are available in previous publications in this series. The characteristic pathological and clinical features of the condition have been mentioned. In making the clinical diagnosis, serological tests were of aid and

have been described elsewhere.[2] For the purpose of orientation, brief summaries of the histories of the above cases are appended:

CASES DIAGNOSED BY AUTOPSY (SERIES I)

1. J.S.,[14] female, white, aged twenty-four days. Convulsions. Slight enlargement of head. Anterior fontanelle large and bulging. Head retracted. Twitching movements of extremities. Deep reflexes hyperactive. Bilateral Babinski signs. Pupils reacted sluggishly to light. Bilateral chorioretinal lesions. Cerebrospinal fluid: xanthochromic, high protein, pleocytosis. Died at thirty days.

2. C.D.,[17] male, white, infant. Onset third postnatal day—convulsions. Left-sided Horner's syndrome. Deviation of eyes to right, nystagmus to right, head retraction—seventeenth day. Lesion of high cervical spinal cord considered to be secondary to birth injury, complete loss of function in fourth week of life. Labile body temperature. Spinal fluid: xanthochromic. Died at thirty-one days.

3. L.M.,[8] female, slightly premature. Hydrocephalus at birth. Roentgenogram of skull, sixth day, small shadows of calcium density in brain. Spinal fluid: xanthochromic, high protein content. Progressive hydrocephalus with terminal convulsions. Subnormal temperature. Died at nine weeks.

4. A.M.T.,[8] white, female, infant. Slightly premature. Evidence of pulmonary infection at two days. Signs of circulatory failure and pyrexia at three days and death on the fourth day.

CASES DIAGNOSED CLINICALLY (SERIES II)

1. P.D.,[2] female, aged three years nine months. Generalized convulsions, poor eyesight and left internal strabismus since early infancy. Mental retardation, and markedly defective speech. Roentgenographic identification of small areas of intracerebral calcification at three years. Ventriculographic demonstration of pronounced internal hydrocephalus at three and one-half years. Bilateral chorioretinal lesions noted at this time.

2. J.F.,[2] male, infant. Jaundice at birth. Enlargement of liver and spleen. Internal hydrocephalus and intracerebral calcification noted during first month of life. Bilateral chorioretinitis observed at thirty-one days. Marked retardation of psychomotor development.

3. A.I.,[2] male, aged two years. Jaundiced fourth day of life. Diffuse maculopapular rash lasting until fourth week. Palpable liver and spleen. Intracerebral calcification at seven weeks. Microcephalus noted at five months. Focal chorioretinitis observed bilaterally at two years. Defective speech.

4. M.B.,[2] female, aged four years. Left internal strabismus noted before age of two months. At four years of age, defective speech. Left microphthalmos. Bilateral focal chorioretinitis. Intracerebral calcification.

5. D.H.,[2] male, negro, aged eleven years. Left external strabismus and "congenital eye lesions" noted at four years. Petit mal attacks beginning at seven years. Old bilateral central chorioretinitis observed at this time. Small area of calcification in brain noted at eleven years. Subnormal intelligence.

6. C.J.,[2] male, aged seven and one-half years. Defective vision, "twitching of eyes," inconstant right internal strabismus noted at three months. Virtual blindness in one eye at one year. Generalized convulsive seizures beginning at eighteen months. At seven and one-half years, central areas of old chorioretinitis noted bilaterally. Electrocephalogram diffusely pathological.

SKULL

Size of the Skull. The skull in 2 instances was microcephalic, A.I. (Fig. 4 to 8) and C.D., while in 3 infants, only a few weeks old, the skull was macrocephalic, L.M., J.S. and J.F. (Fig. 9). In a third child, P.D., hydrocephalus was noted at three and one-half years of age, when ventriculography was performed (Fig. 15). In the other 3 cases, the skull was normal in size.

Shape of Skull. The shape of the skull was not unusual in any of the patients.

Thickness of the Skull. The bones of the vault of one of the microcephalic infants (A.I.) on which three different examinations were made, seven weeks, eleven

Fig. 4. A.I. Toxoplasmic encephalomyelitis. Roentgenogram of skull made approximately six weeks after birth showing multiple areas of calcification scattered throughout both cerebral hemispheres. The skull is distinctly microcephalic. (Courtesy of Dr. E. M. Claiborne, French Hospital.)

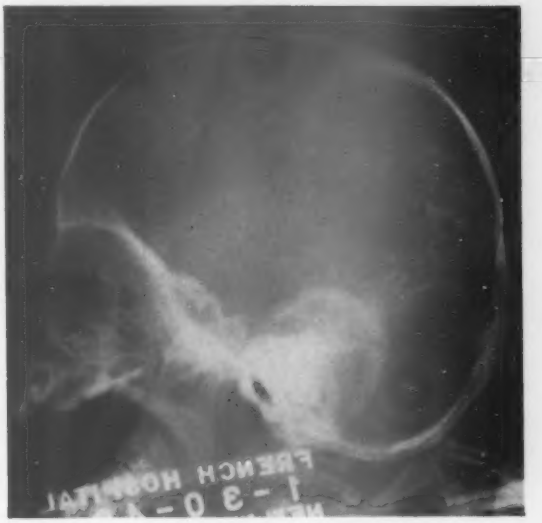

Fig. 6. A.I. Toxoplasmic encephalomyelitis. Lateral roentgenogram of skull made eleven months after birth showing somewhat more clearly the distribution of the areas of calcification and their size and number. Roentgenogram made on same date as that of Figure 5. (Courtesy of Dr. E. M. Claiborne, French Hospital.)

Fig. 5. A.I. Toxoplasmic encephalomyelitis. Roentgenogram of skull made eleven months after birth showing an increase in the number and size of the areas of calcification. (Courtesy of Dr. E. M. Claiborne, French Hospital.)

Fig. 7. A.I. Toxoplasmic encephalomyelitis. Roentgenogram of skull made approximately two years after birth showing a further increase in size and number of the areas of calcification.

FIG. 8. A.I. Toxoplasmic encephalomyelitis. Lateral roentgenogram of skull made approximately two years after birth showing a further increase in the size and number of the areas of calcification. Compare with previous figures.

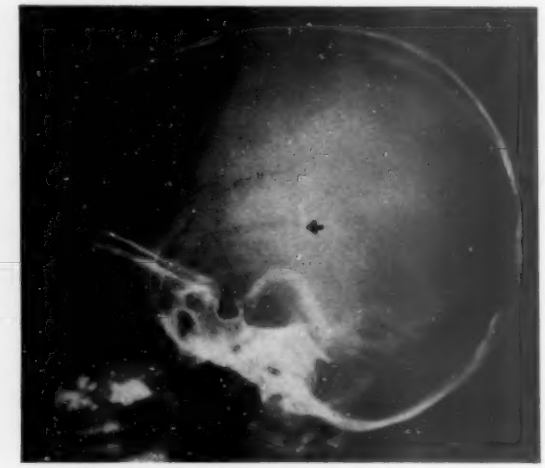

FIG. 10. P.D. Toxoplasmic encephalomyelitis. Lateral roentgenogram showing separation of the coronal suture, atrophy of the sella turcica, and areas of calcification which are probably in the thalami.

months, and two years after birth, showed in each instance, distinct thickening (Fig. 4 to 8). In the earliest examination seven weeks after birth, there was thickening of the occipital bone. In the examination made at eleven months of age, the frontal and parietal bones were thicker than usual, and the bones of the base of the skull appeared rather dense. Furthermore, the examination made two years after birth

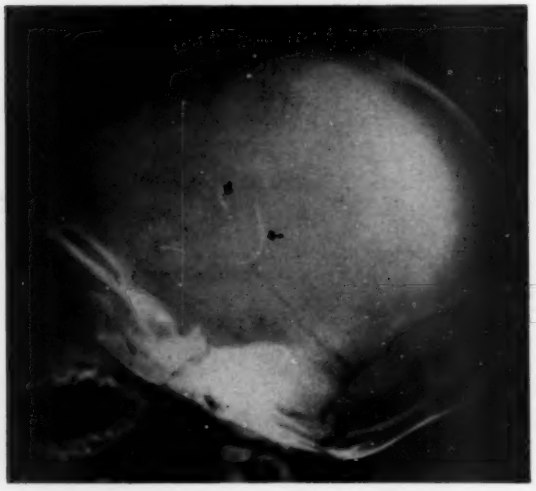

FIG. 9. J.F. Toxoplasmic encephalomyelitis. Lateral roentgenogram showing a moderate degree of hydrocephalus. Note the somewhat vertically disposed streaks of calcification (arrows) in the region of the basal ganglia. Many small areas of calcification are noted in the frontal and central areas of the brain.

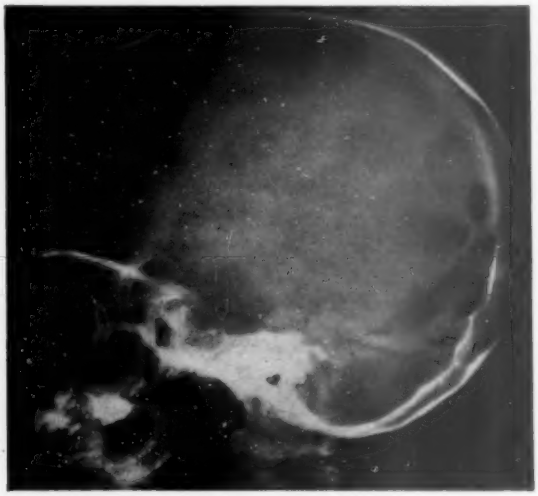

FIG. 11. P.D. Toxoplasmic encephalomyelitis. Roentgenogram made four months after that seen in Figure 10, showing a definite increase in the size of the head, separation of the coronal suture and atrophy of the sella turcica. The areas of calcification remain unchanged.

TABLE I

ROENTGENOGRAPHIC FINDINGS IN INFANTILE OR CONGENITAL TOXOPLASMIC ENCEPHALOMYELITIS

Name	Age at Time of Roentgen Examination	Sex	Roentgenograms of Skull						Long Bones	Chest	Abdomen
			Size	Thickness	Sella Turcica	Sutures	Calcification	Pressure			
Series I. Cases Diagnosed by Autopsy											
J.S.[14] Hist. 491338 X-ray 24482	26 days	F	Hydrocephalic*	Normal	Normal	Normal; wide open fontanelle	Faint flecks in basal ganglia* (reexamination of histological material showed calcium in basal ganglia and thalamus)	Bulging soft tissues through anterior fontanelle*			
C.D.[17]	24 days	M	Slightly microcephalic*	Normal	Normal	Normal; wide open fontanelle	Questionable areas in postcentral region* (histological: abundant calcium)	No	Broad bands diminished density at ends of shafts	Inflammatory reaction right perihilar region	
L.M.[8] Hist. 584135 X-ray 45717	6 days 2 weeks	M	Hydrocepalic	Slightly thinner than normal	Normal	Sutures widely separated; wide open fontanelle	Bilateral caudate nuclei	Bulging at fontanelle	Normal		
A.M.T.[6] S.A. 2890 X-ray 34790	2 days	F							Ribs and clavicles normal	Heart large. Histological: toxoplasmic myocarditis and pneumonitis	
Series II. Cases Diagnosed Clinically											
P.D.[2] Hist. 625175 X-ray 50149	3 yr. 3 yr. and 10 mo.	F	Hydrocephalic	Normal	Moderate atrophy. Posterior clinoid processes short	Separated slightly	Bilateral thalami	Moderate			
J.F.[2] Hist. 633284 X-ray 34152	30 days 2½–3 mo.	M	Hydrocephalic	Normal	Normal	Normal	Flecks near cortical surface, frontal, parietal. Bilateral streaks in thalami. Later examinations showed calcification to have increased	Bulging at fontanelle	Normal	Right upper lobe shadow of increased density—transient	
A.I.[2] Hist. 623468 X-ray 50625	7 weeks 11 mo. 2 yr.	M	Microcephalic	Thicker than normal	Normal	Normal	Multiple flecks mostly in temporal and occipital lobes. Later examinations showed calcification to have increased	No	Normal	Normal	Normal
M.B.[2] Hist. 641809 X-ray 51547	4 yr.	F	Normal	Normal	Normal	Normal	One streak in neck of left caudate nucleus; multiple flecks in cerebrum	No			
D.H.[2] Hist. 534930 X-ray 51618	11 yr.	M	Normal	Normal	Normal	Normal	1 mm. fleck in right caudate nucleus	No		Infiltration near left hilum and small calcium shadows in right upper lobe	
C.J.[2] Hist. 600463 X-ray 50759	7 years	M	Normal	Normal	Normal	Normal	None	No			

* These additional findings, not originally reported, were noted on re-examination of the roentgenograms.

showed generalized thickening of the bones of the vault and of the base, so characteristic of microcephaly.

In the 3 hydrocephalic infants, the cranial bones were slightly thinner than normal, particularly in L.M. The fourth, P.D., an older patient with hydrocephalus, had cranial bones of normal thickness. In the separation of the coronal and sagittal sutures (Fig. 10 and 11). The other 5 cases showed no evidence in the roentgenograms of increased intracranial presure. In case of P.D., the earlier examination revealed evidence of increased intracranial pressure, and the skull was normal in size. However, at a later date the skull showed definite en-

TABLE II

PNEUMOENCEPHALOGRAMS IN CASES OF INFANTILE OR CONGENITAL TOXOPLASMIC ENCEPHALOMYELITIS

	Measurements[2] of Ventricles in Centimeters						Anterior Horns	Temporal Horns	Occipital Horns	Body	Aqueduct	4th Ventricle	Basal Cisterns			Sulci	Appearance of Gas
	No. 1	No. 7	No. 8	No. 3	No. 4	No. 5							Magna	Pontis	Interpeduncularis		
P.D.[2] Hist. 625175 X-ray 50149	6.0	3.5	2.8	2.4	1.0	1.4	Moderately dilated	Markedly dilated	Markedly dilated. Left larger than right	Moderately dilated in anterior two-thirds. Markedly dilated in posterior third	Slightly enlarged	Normal	Normal	Normal	Normal	Few normal	
L.M.[3] Hist. 584135 X-ray 45717	5.5	3.0	2.3	—	—	2.0	Moderately dilated	Markedly dilated	Markedly dilated	Moderate in anterior two-thirds. Markedly dilated in posterior third and atria	Not visible	Not visible	Not visible	Not visible	Not visible	Not visible	Bubbles of gas in ventricles
J.F.[2] Hist. 633284 X-ray 34152	Gas did not enter both lateral ventricles; right ventricle enlarged.						None	None	None	None	None	None	Normal	Enlarged	Enlarged	None	Bubbles in ventricles and in subdural or subarachnoid space. Large space between skull and brain

other cases, there was no significant alteration in the thickness of the bones of the vault or base of the cranium.

Evidences of Increased Intracranial Pressure. In 3 infants, J.F., L.M. and J.S., there was slight but distinct bulging of the anterior fontanelle, and in one of these cases (J.F.) the mastoid fontanelle was large. Two weeks later, this fontanelle had decreased considerably in size. Another patient (P.D.), who was three and one-half years of age at the time of examination, showed evidence of atrophy of the posterior clinoid processes and dorsum sellae, and largement, and evidence of increasing intracranial pressure.

Intracranial Calcification. The most striking roentgenographic evidence of toxoplasmic infection of the brain in infants and children is that resulting from intracerebral calcification. This occurred in 8 of the 9 patients (Table 1). Roentgenograms of the skull were not taken in the tenth case. In 6 instances, calcification was present in both cerebral hemispheres. In one of the unilateral cases (D.H.) there was a single small area of lime salt deposit in the right cerebral hemisphere in the region of the

neck of the caudate nucleus. In the other there were faint shadows in one postcentral region. In the 6 instances with bilateral cerebral calcification, there were multiple small, more or less rounded areas of lime salt deposit. In one instance (A.I.) (Fig. 4 to 8), many small areas of calcium density were noted in the parietal, occipital and temporal areas, where they were more numerous in the frontal region. In another case (J.F.) there were diffuse focal deposits of calcium but they appeared to be more numerous in the frontal area, although there were some in the parietal and occipital regions. In 3 instances (J.F., P.D. and L.M.) there were curvilinear streaks of calcification in the basal ganglia or thalami (Fig. 10 and 11). These curvilinear streaks of calcium density are the most characteristic but not the most common feature of the disease. Multiple small collections of lime deposits, 1 to 3 mm. in diameter, are particularly prone to occur in this infection of the brain.

In one of the microcephalic infants (A.I.) the examination of the skull made seven weeks after birth showed multiple flecks of calcium scattered throughout both cerebral hemispheres. The examination made at eleven months of age revealed the calcium deposits to be larger and more numerous. The third examination, made when the child was two years of age, revealed a still further increase in the size and number of the calcium deposits.

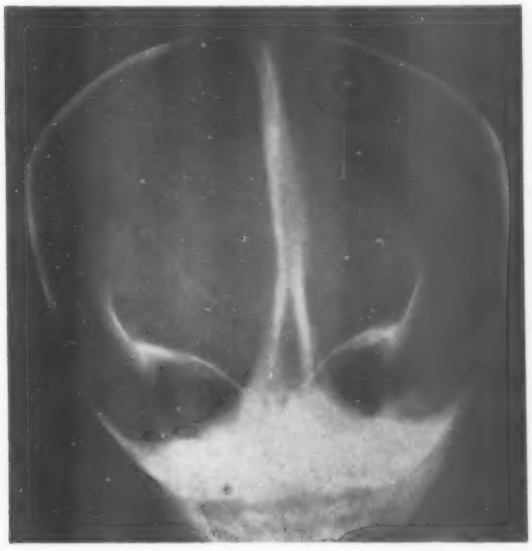

Fig. 12. L.M. Toxoplasmic encephalomyelitis. Posteroanterior roentgenogram showing the marked internal hydrocephalus. Note the bubbles of gas in the ventricles which are probably due to increased protein in the cerebral fluid.

Fig. 13. L.M. Toxoplasmic encephalomyelitis. Lateral roentgenogram showing the tremendous destruction of the parietal, occipital and temporal lobes of the brain, and the moderate destruction of the frontal lobes. Note bubbles of gas.

Pneumoencephalographic Appearance of the Brain (Table II). Three (L.M., P.D. and J.F.) of the 10 cases had air studies performed on them. In 2 instances (L.M. and P.D.) the ventricles were well visualized and in both instances, they were markedly enlarged (Fig. 12, 13 and 14). The frontal horns in these 2 cases were enlarged, but the main enlargement involved the bodies, atria, occipital and temporal horns (Fig. 15). The lateral ventricles were in their normal position in the lateral plane and in one case (P.D.) the third ventricle was visualized and was enlarged. In both of these cases there was evidence of increased intracranial pressure, and in one case there was separation of the sutures (P.D.). It is probably fair to conclude that the enlargement of the lateral ventricles was not due solely to an obstruction of the aqueduct of Sylvius and/or the interven-

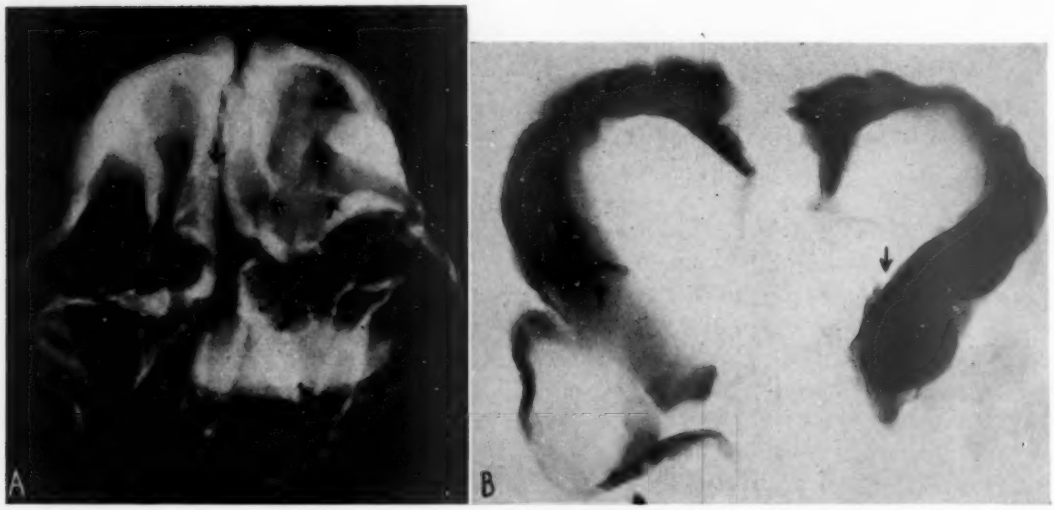

FIG. 14, *A* and *B*. L.M. Toxoplasmic encephalomyelitis. Roentgenogram of the brain, postmortem, which confirms the roentgenographic evidence of brain destruction. Arrows point to calcium in basal ganglia.

tricular foramina, because the ventricular dilatation was unequal; the frontal horns were not as dilated as the remainder of these cavities. The enlargement of the ventricles must therefore be ascribed at least in part to actual destruction of the brain and from the ventriculographic evidence the destruction in the present cases was greater in the temporal, parietal and occipital lobes than in the frontal. In the third case (J.F.) the gas was introduced through the fontanelle and it was found to occupy mainly the subarachnoid and subdural spaces and only a small amount was seen in the ventricular system. The single ventricle (right) which was visualized was enlarged to a moderate degree. The basal cisterns were distinctly enlarged and the few sulci markings which were seen were coarser than usual.

FIG. 15. P.D. Toxoplasmic encephalomyelitis. Anteroposterior ventriculogram showing the generalized dilatation of the ventricular system. The atrial portions and temporal horns are proportionately much larger than the frontal horns.

In 2 (J.F. and L.M.) of the 3 cases, the visualized intraventricular space had a regular mosaic pattern. This was interpreted as indicating the presence of bubbles which had persisted, following the introduction of gas (Fig. 12 and 13). The fact that gas bubbles had persisted in 2 of 3 cases of toxoplasmic encephalomyelitis is unusual, and the question has arisen whether this is due to the amount of protein in the cerebral fluid. In one instance (L.M.), the cerebral fluid protein was 323 mg. per 100 cc. and in the other case (J.F.) it was 110 mg. per 100 cc. at the initial examination. In the second (J.F.) there was a small amount of gas in the subdural

space over both cerebral hemispheres, and in various positions there seemed to be more than the normal potential space, indicating an atrophy of the brain. However, it could not be determined which portion of the brain was most affected in this patient. In a third case (P.D.) the gas did not form bubbles, and the protein of the cerebral fluid was 19 mg. per 100 cc. Since the normal protein in ventricular fluid is 5–15 mg. per 100 cc. the bubbling effect in the first 2 cases may have been associated with the increased protein. It may be that other substances such as lipids from the degenerated ventricular walls contributed to this phenomenon.

CHEST

In 5 instances (A.I., A.M.T., J.F., C.D. and D.H.) roentgenograms of the chest were made. In one child (A.I.) two years of age at the time of examination, the lungs appeared normal. In 3 cases (C.D., J.F. and D.H.) the lungs appeared abnormal. In C.D. there was a patchy shadow of increased density in the right perihilar region which was consistent with an inflammatory process. The roentgenograms of J.F. (Fig. 16) showed consolidation of the right upper lobe which continued for a week before it disappeared. These pulmonary changes may not have been manifestations of toxoplasmic infection, since they are similar to inflammatory or atelectatic lesions found in infants without toxoplasmosis. In the third child (D.H.), there were small calcified lesions in the right upper lobe and an area of increased density above the left hilum. This patient had a positive Mantoux test. In a fourth infant (A.M.T.), the roentgenograms of the chest revealed enlargement of the heart. The pathological studies disclosed toxoplasmic myocarditis and pneumonitis.

Fig. 16. J.F. Roentgenogram of the chest showing shadow of increased density in the right upper lung field.

Fig 17. C.D. Defective mineralization at the ends of the long bones.

LONG BONES

The skeleton was examined in part in 5 instances. The long bones of C.D. showed, in the terminal segments of the shafts, deep transverse zones of diminished density

(Fig. 17). These changes are similar to the lesions that have been seen at the epiphyseo-diaphyseal junctions in syphilitic newborn infants, and in a variety of severe infectious and nutritional disorders in the neonatal period, and they are probably not specific for toxoplasmosis.[1] In the vertebral column, the provisional zones of calcification in the superior and inferior margins of the vertebral bodies were exaggerated into heavy white borders. Internal to the heavy white lines there were parallel linear zones of decreased density similar to the deep transverse zones in the ends of the shafts of the long bones. In the other 4 cases, the long bones were normal.

DIFFERENTIAL DIAGNOSIS

Toxoplasmic infection of the central nervous system must be differentiated from a number of intracranial lesions which may undergo calcification. The most important of these is *brain tumor*, which is infrequent in infants. In older children, brain tumors are more common, but are infrequent supratentorially. Two types are prone to calcification, the *craniopharyngioma*, which is characterized by calcification in and above the sella turcica, and the *venous angioma*, which is almost invariably located in the parieto-occipital region near the great longitudinal fissure. In either instance, the calcification is focal and limited to a single area, and in the case of the *venous angioma*, the calcium is deposited in linear streaks which are often parallel.

In *tuberous sclerosis*, multiple areas of calcification often occur. These are usually situated along the roofs of the lateral ventricles, although such areas may be found also in the lateral portions of the cerebral hemispheres. There may or may not be evidence of increased intracranial pressure, and the disease is usually recognized in older children or adults.

Cerebral calcification epilepsy[5] is a disease which may be familial, and in this condition, multiple large areas of calcification are scattered throughout both cerebral hemispheres. This disease is usually not recognized except in older children and adults.

Symmetrical cerebral calcification,[4] particularly of the basal ganglia, has been described in older children and adults. In these cases, the calcium deposit is usually limited to the basal ganglia and there is an absence of increased intracranial pressure.

Calcified subdural hematoma is usually recognized in children or adults and not in early infancy. Furthermore, in a hematoma, the calcium is adjacent to the inner table of the skull, and it is in the form of linear streaks as well as in more or less punctate forms.

Tuberculoma is a rather rare lesion of the brain in infants and children and usually affects the cerebellum. When such a lesion calcifies, the calcium deposits are localized and not diffusely scattered throughout the cerebral hemispheres as in toxoplasmosis.

Cysticercus cellulosae is rarely encountered in man in the United States. The disease usually occurs in adults, and the areas of calcification are most numerous along the posterior limb of each sylvian fissure, and at the base of the brain. The deeper portions of the brain are usually not involved.

Intracerebral hematoma containing calcium is rare. Undoubtedly, minute hemorrhages within the substance of the brain may undergo calcification but they usually are not recognized except in adults.

SUMMARY AND CONCLUSIONS

The roentgenographic findings in ten cases of infantile or congenital toxoplasmic encephalomyelitis have been described. In four of these, the diagnosis was not made until necropsy, while six were diagnosed clinically and are still living.

Diffuse intracerebral calcification is the most striking roentgenographic evidence of infantile or congenital cerebral toxoplasmosis. It usually occurs in small flecks approximately 2 mm. in diameter, or in streaks, particularly in the basal ganglia or thalami. Intracerebral calcification was

noted in eight of the nine patients whose skulls were examined roentgenographically.

Evidence of increased intracranial pressure was noted in four of the cases.

Three of the patients who had pneumoencephalography showed marked internal hydrocephalus.

Multiple cerebral calcification in infants and young children makes it imperative that the diagnosis of toxoplasmosis be seriously considered.

Pneumonitis may occur in the disease, and in one case, *Toxoplasma* was demonstrated at necropsy to be the cause of the pulmonary inflammation.

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DISCUSSION ON PAPERS BY SANTE, AND DYKE, ET AL.

Dr. Leo G. Rigler, Minneapolis, Minn. My discussion will be confined to Dr. Sante's paper, as I really know too little about Dr. Dyke's presentation to offer any comments at all.

With the introduction of specific chemotherapy for pneumonia there has been a somewhat unfortunate tendency on the part of both clinicians and radiologists to abandon our previous efforts at classification of pneumonias into various types and as to various etiological agents. This tendency is natural in view of the fact that the vast majority of pneumonias respond so well and so uniformly to various of the sulfonamide group of drugs.

The effort to distinguish various types of pneumonia by roentgenographic findings is hazardous in the extreme, yet, to some degree, a differentiation can be made and should be attempted wherever possible. Thus we have seen recently an epidemic of pneumonia which to the consternation of the clinical staff did not respond at all to specific chemotherapy. Sputum in these cases showed no specific organisms and, in the opinion of our staff, the etiological agent was a virus of some type, although this is very difficult to prove. In any event it was important for us to indicate to the clinical staff that the roentgenologic features of this particular epidemic of pneumonia were strikingly different from the ordinary or pneumococcus pneumonias which we more commonly see, so that thereafter there was no great surprise at the response to chemotherapy, and other measures were taken.

The cases reported by Dr. Sante, therefore, I believe are of considerable importance as giving at least some clue in the roentgen examination to the unusual character of the etiological agent of this particular pneumonia. Personally, I have had no experience whatsoever with this particular etiological agent. We have, however, seen a number of cases we have called interstitial pneumonia which, on pathologic examination of lung tissue, resemble somewhat the sections Dr. Sante showed; we did not at that time recognize them as being due to *Toxoplasma*, and I don't know now whether they were.

There are a number of unusual types of pneumonia that we see and it may be well worth while looking at one or two merely by way of contrast with what Dr. Sante has shown, to bring it out.

(Slide) I show this first slide because Dr. Sante mentioned the resemblance to ordinary pulmonary edema. This is one of the cases we reported this year and there is some resemblance. Edema has a much more diffuse distribution but otherwise looks a good deal like it.

(Slide) This is typical of a group of what we think are virus pneumonias which show nodular areas throughout the lungs, and differ so distinctly from this other type.

(Slide) The final slide demonstrates an unusual type of case which we call allergic pneumonia—individuals who give a very bizarre, irregular picture of pulmonary infiltration sometimes on both sides, sometimes on one, which clears up very, very slowly and is accompanied by extreme eosinophilia. In some of these the eosinophilia and pneumonic manifestations in the lung have occurred as a reaction to the drugs used for chemotherapy of other conditions.

DR. JUSTIN E. MCCARTHY, Cincinnati, Ohio. We have all seen cases of atypical pneumonia both in their roentgen manifestations and in clinical findings.

After having seen Dr. Sante's slides and reviewing them with him, I am wondering whether or not some of the cases that we have been wont to call atypical pneumonia weren't due to toxoplasmosis, and when we see such a case in the future, we should consider this in the differential diagnosis.

In looking over Dr. Dyke's exhibit, I was reminded of a case that has been puzzling me since the latter part of the spring. This patient was presented to me because of the unusual calcification of the skull. I have shown it to several men with no comments and when I saw Dr. Dyke I also presented the films to him, and he thinks that this case should be considered one of toxoplasmosis. I would like to show these slides.

(Slide) This is the lateral view, and you see the calcification in the ventricles, and the anteroposterior view—I think you can see much better, the fine wall of the ventricles.

DR. A. B. SABIN, Cincinnati, Ohio. The conditions discussed by Dr. Sante and Dr. Dyke may seem a little strange to you. For although *Toxoplasma* has been known as a new genus of protozoa since 1909, it is only in the past two years that it has been definitely established as the cause of disease in human beings. The habit of parasitologists to identify protozoa chiefly on morphological grounds was responsible for the long delay and resulting confusion. Thus the reports of some investigators as early as 1914 that they found protozoa of toxoplasmic morphology in human beings were "authoritatively" denied, while others as late as 1937 have reported various "new" conditions and parasites which we now have good reason to interpret as excellent examples of toxoplasmosis.

The new orientation came with a better understanding of the biological properties of *Toxoplasma* and the discovery that monkeys and human beings (although not certain other animals) develop specific antibodies in response

to toxoplasmic infection. The isolation of *Toxoplasma* by suitable animal transmission and the use of suitable serological tests has given us the present appreciation of the protean clinical manifestations of toxoplasmosis in man. At the present time we have come to distinguish at least three distinct types of the infection in human beings: (1) the congenital (infantile) type in which marked destruction of tissue in the central nervous system gives rise to a tetrad of clinical signs all which may be present in a typical case—hydrocephalus or microcephaly, cerebral calcification, chorioretinitis, and such signs of cerebral damage as convulsions, mental retardation, etc.; (2) the childhood type which thus far has manifested itself as an acute encephalitis, and (3) the adult type thus far characterized by a spotted fever-like syndrome associated with diffuse pneumonitis.

It seems to me that the roentgenologist's rôle in detecting cases of this disease will be chiefly to suggest that the various procedures available for establishing a diagnosis of toxoplasmosis should be resorted to when evidence of cerebral calcification is found in young infants or children. Factors other than roentgen evidence of a diffuse pneumonitis will probably play a more important rôle in leading us to suspect toxoplasmosis in older children and adults.

Toxoplasmosis is primarily a disease of lower animals which is transmitted to man. We have good reason to suspect dogs, cats, rabbits, guinea pigs, squirrels, voles and possibly mice and rats as probable reservoirs of the infection. Although almost everyone speaking or writing on this subject invariably incriminates birds, it should be noted that thus far the various parasites found in birds which may resemble *Toxoplasma* have neither been established as *Toxoplasma* nor been shown to be pathogenic for mammals. Work which Dr. Warren and I have carried on for the past two years has shown that of the many drugs which are therapeutically effective against other protozoa none could control toxoplasmic infection. On the other hand, sulfathiazole and sulfapyridine, but not sulfanilamide, were found to exert a curative effect against *Toxoplasma* in mice and rabbits, provided the therapy is continued for weeks. Sulfanilamide, which is ineffective in animals, has been used in two human fatal cases (one reported by Pinkerton and Henderson and the other by myself), but the effective sulfonamides have not yet been used in human beings.

In conclusion, I wonder if Dr. Dyke could tell us whether he has as yet observed any roentgenological characteristics which might differentiate between the cerebral calcification of toxoplasmosis and other types of intracranial calcification.

Dr. Sante (closing). I want to thank Dr. Rigler, Dr. McCarthy, and Dr. Sabin for their kind discussion.

With reference to chemotherapy, I think I must say that chemotherapy was not of any advantage as far as we could see in one of these cases. The female patient received a course of sulfanilamide, 40 grains for three days, and showed no manifestation of any change at all, so that chemotherapy was abandoned. At any rate, it seemed to us that in this respect it resembled the action of a virus disease.

I agree with Dr. Rigler that, after all, the roentgenologist cannot hope to diagnose toxoplasmosis from a roentgenogram of the chest. He can go no farther than to say that there is an atypical form of pneumonitis present and to suggest to the pathologist the possibility of something unusual. I will be up to the pathologist, by whatever tests are at his command, to determine the true nature of the infection.

The inference that birds can be eliminated as a possible source of virus and kindred diseases such as psittacosis and toxoplasmosis, is, I think, open to question. For instance we think of psittacosis (a parrot fever) as being a rare disease which occurs only in California; we feel that we don't have to worry about it very much in other localities. The pathological picture of psittacosis as shown in microscopic slides is, I am informed, exactly the same as toxoplasmosis, minus the organisms and minus the ability to transmit the disease to other animals and again recover the organism. Now I am informed, it has been found that psittacosis occurs not only in parrots, but in pigeons and chickens as well. Since the disease may be conveyed by the excreta and since these birds are distributed throughout the entire country it is very possible that psittacosis itself may account for some of these virus-like infections which we are encountering. The same thing is true of other types of virus. All of these types of infection seem to produce interstitial type of inflammation and pneumonitis, with swelling and enlargement of alveolar epithelium to form a cuboidal cell type of lining of the alveoli, a

gelatinous, cell-free alveolar exudate and a curled-up membrane lining the alveolar spaces which result in cyanosis, so that it may be difficult for even the pathologist to distinguish between the various types of infection from the microscopic examination. Certainly the most the roentgenologist can hope to do is to point out that the case in question may be due to some unusual type of infection so as to direct the attention of the pathologist to this possibility.

DR. DYKE (closing). I wish to thank the gentlemen for discussing the paper, and although I would like to discuss the differential diagnosis of toxoplasmosis, of brain tumor, and tuberose sclerosis in detail, it would take too much time to do so here. I shall be very glad to see those who are interested in the differential diagnosis of toxoplasmosis at the exhibit and discuss it with them there. It will be taken up in detail in the manuscript.

Dr. McCarthy's case, of which he showed two lantern slides, interests me very much. I believe it is definitely due to an inflammatory process. It seems his patient may very well have had an appendymitis due to the *Toxoplasma* protozoan. The only other suggestion I have is that it may be a calcified wall of a hematoma adherent to the appendymal lining of the lateral ventricles.

Vol. 47, No. 6

THE SPHENOIDAL FISSURE

AN ANATOMICAL, ROENTGENOLOGICAL AND CLINICAL STUDY*

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THE roentgen examination of the skull has become an indispensable procedure in the clinical investigation of patients suspected of harboring an intracranial neoplasm. The present status of neurosurgery is, in a large measure, due to the great aid rendered by roentgenology in the accurate detection and localization of brain tumors. Carefully made and critically analyzed roentgenograms of the skull will in the majority of instances detect the presence of such a lesion. This is attested to by the fact that two-thirds of all brain tumors produce some alteration in the structure of the sella turcica. This aids very materially in establishing the diagnosis of brain tumor. All too frequently, however, the type of deformity of the sella is not sufficient to indicate the nature or location of the lesion. As a matter of fact, the only sellar deformity that is pathognomonic is that produced by an intrasellar tumor; that is, a pituitary adenoma. In view of this fact one must often search for other signs to aid in the diagnosis. Many such roentgen manifestations are in common use such as the evidence of increased intracranial pressure, calcifications, localized hyperostosis and bone erosions. We wish to call attention to a roentgen finding which has received little if any mention in the American literature dealing with the roentgen diagnosis of brain tumors, namely, alteration in the size, shape or appearance of the sphenoidal fissure.† This abnormality occurs with sufficient frequency to make it of distinct value in the recognition of either an intracranial or intra-orbital lesion. Because of the value that this sign has been to us in our routine work it was thought advisable to study this fissure both anatomically and roentgenologically and to correlate the results of such study with the clinical investigation of cranial pathology.

ANATOMY OF THE SPHENOIDAL FISSURE

The sphenoidal fissure is also known as the superior orbital fissure. A good anatomical description may be found in any standard textbook of anatomy. The following is a composite description derived from several authoritative works (Fig. 1). The sphenoidal fissure is located in the posterior portion or apex of the orbit. It is an irregular, narrow, slit-like opening between the greater and lesser wings of the sphenoid bone. As seen from in front, it is obliquely placed in the posterior wall of the orbit, its direction being from below upward and outward. The lower and medial portion is wider than the outer and upper portion. It is bounded above by the lesser wing, below by the greater wing, medially by the body of the sphenoid bone and laterally by the orbital plate of the frontal bone. Below the medial end of the fissure is the foramen rotundum and these two openings are sometimes connected, forming a single opening. Above and medially is the optic foramen. In the floor of the orbit is a somewhat similar but smaller fissure known as the inferior orbital fissure. Above the sphenoidal fissure, the free edge of the lesser and greater wings of the sphenoid bone merge at the lateral extremity of the fissure to form the posterior free edge of the anterior cranial fossa. This edge is commonly referred to as the sphenoidal ridge.

The sphenoidal fissure connects the middle cranial fossa behind with the orbit in

† A brief discussion of this subject is to be found in A Textbook of X-ray Diagnosis, By British Authors, Vol. III, p. 56.

* From the Department of Roentgenology, Jefferson Medical College and Hospital, Philadelphia. Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

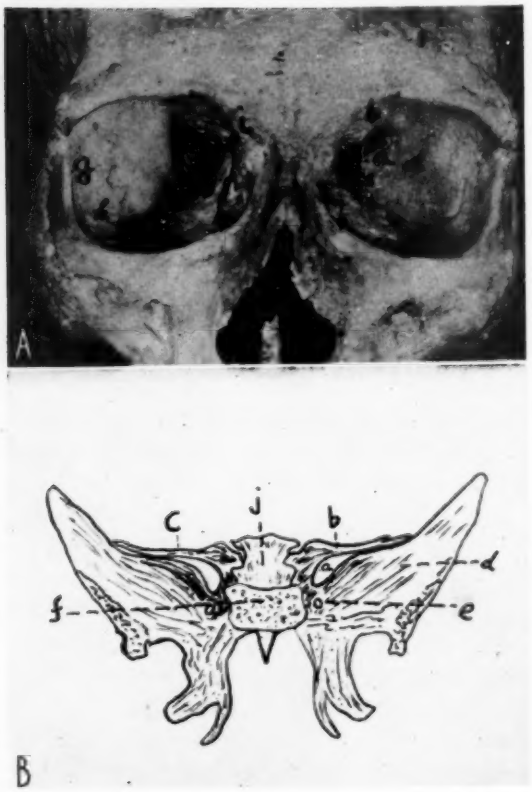


FIG. 1. *A*, anatomical specimen showing the important structures of the orbit. *B*, the sphenoid bone as seen posteriorly. *a*, the sphenoidal or superior orbital fissure; *b*, lesser wing of sphenoid; *c*, sphenoidal ridge; *d*, greater wing of sphenoid; *e*, foramen rotundum; *f*, body of sphenoid bone; *g*, orbital plate of frontal bone; *h*, inferior orbital fissure; *i*, optic foramen; *j*, sella turcica.

front and serves as a means of transmission of the various structures from the cranial cavity to the orbit. Through it pass the oculomotor, the trochlear, the abducens nerves and the ophthalmic division of the trigeminal as well as some fibers from the cavernous plexus of the sympathetic. The orbital branches of the middle meningeal artery, the recurrent branch of the lacrimal artery and the ophthalmic vein also pass through this fissure.

Roentgenological experience has acquainted us with the fact that there is considerable variation in the size and shape of the normal sphenoidal fissure. To become more familiar with the anatomy and the normal variations, a study was made of this fissure from anatomical specimens placed at our disposal through the courtesy of Dr. J. Parsons Schaeffer, Director of the Daniel Baugh Institute of Anatomy of the Jefferson Medical College. One hundred and ninety-one skulls were examined, 34 of which had to be discarded because of artificial defects which were found in the sphenoidal fissure. While considerable variation was found in the size and shape, it was possible to recognize definite configurations permitting the fissures to be grouped into six distinct types (Fig. 2). The configuration which predominated we designated the normal sphenoidal fissure. The other groups were regarded as variants of this normal type. In general, the normal sphenoidal fissure as determined from the anatomical specimens measures 15 mm. in length and 5 mm. at its greatest width. The fissure is largest at its lower and medial portion, being globular or bulbous in shape and then tapering off gradually to a point at its upper and outer end. Descriptive names were given to the variants as indicated in

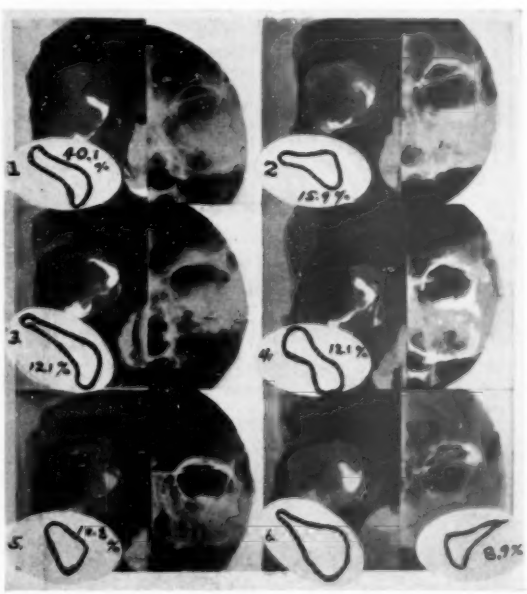


FIG. 2. The normal sphenoidal fissure and its variants, with the percentage of each. The anatomical and roentgenological appearance of each specimen. *1*, normal sphenoidal fissure; *2*, the bulbous type; *3*, the long narrow type; *4*, the dumbbell type; *5*, the cone-shaped type; *6*, the unequal fissures.

Table I, which also gives the number and percentage of each variant found in this study of anatomical specimens.

In the bulbous type the lower and inner end of the fissure is larger and distinctly more bulbous than is found in the normal fissure. The long, narrow fissure shows less variation in its width from one end to the other. At times the fissure shows a bulbous expansion at both ends giving rise to a dumbbell appearance. Instead of the usual tapering off, the sides often remain somewhat expanded, the shape resembling a cone. Of considerable importance is the recognition that the normal sphenoidal fissures may show asymmetrical development. One fissure may be larger than the other or there may be a distinct difference in their shape. This assumes considerable roentgenological significance since pathological changes are usually recognized by comparing one fissure with the other.

Table I

CLASSIFICATION OF THE NORMAL SPHENOIDAL FISSURE ON THE BASIS OF CONFIGURATION, AS DETERMINED FROM A STUDY OF 157 ANATOMICAL SPECIMENS

		per cent
Normal fissure	63	40.12
Bulbous type	25	15.92
Long, narrow type	19	12.10
Dumbbell type	19	12.10
Cone-shaped type	17	10.82
Unequal fissures	14	8.91

ROENTGENOLOGICAL STUDY OF THE SPHENOIDAL FISSURE

The roentgen appearance of the orbit differs somewhat from that seen in the anatomical specimen. In the projection used to demonstrate the sphenoidal fissures one of the striking features noted is the sphenoidal ridge which passes across the upper portion of the orbital cavity just above the sphenoidal fissure. This important landmark cannot, of course, be seen in the frontal view of the anatomical specimen. The optic foramen, the inferior orbital fissure and the foramen rotundum are usually obscured by superimposed structures in the roentgenogram. The sphenoidal fissure itself, however, has essentially the same appearance in both the roentgenogram and the anatomical specimen (Fig. 2).

Some years of experience have given us considerable familiarity with the roentgenological appearance of the sphenoidal fissure, and particularly in recent years since we have become interested in its importance from a clinical point of view. To determine whether the results of our anatomical studies could be confirmed roentgenologically, a series of 532 consecutive roentgen examinations of the skull were carefully studied as regards the appearance and anatomy of the sphenoidal fissure. It was of interest that the same classification based on the configuration of the fissure as found in the anatomical specimens was maintained in the roentgenological series. When analyzed on the basis of the percentage of each type it is interesting to note how closely the two series compare (Table II). Of 532 cases studied there were 30 in which the sphenoidal fissures were not well shown. This forms an important group as will be subsequently discussed. Of the remaining 502 there were 8 in which a sphenoidal fissure was definitely abnormal, leaving 494 normal cases for analysis. The percentage frequency of the various normal types is given in Table II.

Table II

CLASSIFICATION OF THE NORMAL SPHENOIDAL FISSURE AS DETERMINED FROM A STUDY OF 494 ROENTGEN EXAMINATIONS OF THE SKULL

		per cent
Normal fissure	189	38.26
Bulbous type	72	14.57
Long, narrow type	58	11.74
Dumbbell type	46	9.31
Cone-shaped type	86	17.41
Unequal fissures	43	8.70

Our routine examination of the skull includes an ordinary posteroanterior view. In this projection the sphenoidal fissures are usually well shown. However, in the study of the 532 examinations above referred to, we were surprised to find the frequency with which the fissures were not very well delineated, even in apparently

normal skulls. This fact has also impressed us in our daily work, now that we are giving special attention to these structures. In the series of roentgenograms studied, there were 30 cases in which the fissures were not sufficiently well shown to determine the type. These cases were analyzed to determine the cause of the non-visualization of the fissures, with the result as shown in Table III.

TABLE III

ANALYSIS OF THE CAUSE OF POOR VISUALIZATION OF THE SPHENOIDAL FISSURES

Blurring due to motion	3
Improper position of head	12
Underexposure of film	6
Unexplained	9

This analysis indicates that poor roentgenographic technique is the chief cause for the failure to satisfactorily visualize the sphenoidal fissures since 18 out of 30 cases were due to this factor. It is important, therefore, that some mention be made of the roentgenographic technique used to visualize the sphenoidal fissures. To obtain optimum results, we experimented with various positions of the head, various angulations of the tube and various technical factors. We found that none of the techniques used gave consistently satisfactory visualization of the fissures. We finally came to the conclusion that our usual posteroanterior projection was most satisfactory for routine work. The technique is as follows: The examination is conducted with the patient in the erect position, as is all of our head work. Intensifying screens and the Potter-Bucky diaphragm are used. The head is placed with the forehead and nose touching the Potter-Bucky diaphragm. A compression band is used to immobilize the head. The target-film distance is 40 inches. The tube is angled 15 degrees toward the feet. The central ray is directed toward the external occipital protuberance and emerges through the middle of the orbit. The kilovoltage is the only variable factor and this varies with the thickness of the patient's head. In the average adult the following factors are employed: 68 kilovolts, 20 milliamperes with $3\frac{3}{4}$ seconds' exposure.

Not infrequently this technique fails to give satisfactory visualization of the fissures and this without apparent cause. In the series of 30 cases analyzed, 9, or approximately one-third, fell in this category. In such cases we find it necessary to re-examine the patient, changing the technique to suit the individual case. Different angulation of the tube, changes in the physical factors or a somewhat different position of the head may be advantageous. We often resort to the use of the technique employed in examinations of the frontal sinuses, namely the Caldwell position, without the aid of the Potter-Bucky diaphragm. This technique will often show the sphenoidal fissures beautifully. Good visualization may be had in the oblique position of the orbit but only one fissure at a time is shown and since it is rather difficult to duplicate the same position on the two sides, comparison of the fissures becomes difficult.

We have used body section roentgenography in the study of the sphenoidal fissure but as yet have not been materially helped by this procedure. We feel, however, that this method holds promise of showing to better advantage the precise changes that occur in the sphenoidal fissure.

Success in the use of the roentgen ray in any part of the body depends in a large measure upon the expertness with which the roentgenograms are made. This applies equally as well to the head as to other parts of the body. Therefore, the importance of technique as regards the examination of the skull, and in the present instance, the sphenoidal fissures, cannot be too strongly emphasized. The most important single technical factor is the proper positioning of the head. This accounts for more technical errors than any other factor. Since an accurate interpretation of the sphenoidal fissures is dependent on a comparison of the two fissures, an abolute straight posteroanterior view is necessary. The slightest rotation in any direction will impart to each fissure a different appearance.

Clinical Value of the Examination of the Sphenoidal Fissure

The diagnostic value of any roentgen sign is, in a measure, dependent upon the frequency of its occurrence or incidence. In an analysis of a recent series of 68 cases of verified brain tumor there was found an abnormality in the sphenoidal fissure in 19, an incidence of 27.9 per cent. While this series is not large, nevertheless it gives some idea as to the frequency of sphenoidal fissure deformity. Any roentgen sign which is present in approximately one-fourth the cases of a given condition is a manifestation of considerable importance. In a previous publication[1] the incidence of various roentgen manifestations of intracranial tumor was determined from a study of a large series of verified brain tumors. Table IV, which includes the incidence of sphenoidal fissure deformity, gives a comparative value of this sign along with the other roentgen manifestations of brain tumor.

From Table IV it is seen that sphenoidal fissure deformity ranks second in incidence among the various roentgen manifestations of intracranial neoplasm and thus, in this condition, it becomes a roentgen finding of major importance.

Table IV

Incidence of various roentgen manifestations of intracranial tumor occurring in a series of 446 verified cases

	per cent
1. Deformation of the sella turcica	64.6
2. Convolutional atrophy	8.8
3. Calcification of the tumor	6.5
4. Widening of the sutures	4.6
5. Local bone erosion	2.9
6. Local hyperostosis	1.8
7. Lateral shift of the pineal body	1.8
8. Widened diploic channels	0.2
Sphenoidal fissure deformity	27.9

While some of the roentgen manifestations of brain tumor indicate the presence of an intracranial neoplasm, frequently they do not give any information regarding the location of the lesion. This is true of deformations of the sella turcica, the most frequent and most important of all roentgen manifestations of brain tumor. Aside from pituitary adenoma the deformity produced in the sella turcica is usually not sufficiently characteristic to indicate the location of the lesion. The large group of extrasellar tumors producing sellar changes may be situated anywhere in the intracranial cavity, either above or below the tentorium. Early in this study we were under the impression that a deformed sphenoidal fissure was due to direct pressure of the tumor upon the bony structure of the fissure and that the finding of such a deformity gave an accurate localization of the lesion. With this in mind we determined the location of the tumor in 26 cases showing alteration of the sphenoidal fissure (Table V).

Much to our surprise there were 6 tumors (5 posterior fossa and 1 parietal lobe) that

Table V

A recent series of verified brain tumors showing the occurrence of sphenoidal fissure deformity in relation to the location of the tumor. Also the occurrence of unilateral and bilateral involvement*

		Sphenoidal Fissure Deformity	Unilateral	Bilateral
Parasellar tumors	12	8	7	1
Posterior fossa tumors	15	5	3	2
Frontal lobe tumors	13	4	3	1
Pituitary tumors	10	3	1	2
Intra-orbital tumors	2	2	2	0
Tumors of sphenoid sinus	2	2	1	1
Temporal lobe tumors	6	1	1	0
Parietal lobe tumors	8	1	0	1
Suprasellar tumors	3	0	0	0
Ventricular tumors	2	0	0	0
Occipital lobe tumors	2	0	0	0
	75	26	18	8

* Seven cases in this series were obtained from Dr. Arthur Finkelstein, Director of the Department of Radiology, Graduate Hospital, Philadelphia. Our indebtedness to him is herewith acknowledged.

[1] Kornblum, K. Responsibility of the roentgenologist in the detection of intracranial tumors. Am. J. Roentgenol. & Rad. Therapy, 1935, *33*, 752–763.

were much too far removed to exert direct pressure upon the sphenoidal fissure. The sphenoidal fissure deformities found in these cases are apparently due to generalized increased intracranial pressure since all but one (parietal lobe meningioma) showed distinct roentgen signs of increased intracranial pressure such as convolutional atrophy, widening of the sutures and thinning of the bones of the vault. The cause of the sphenoidal fissure deformity in these cases is evidently a part of the generalized thinning of the cranial bones commonly observed in the presence of increased intracranial pressure. In such cases the effect upon the sphenoidal fissures is usually a generalized demineralization of the surrounding bone causing the fissures to be very indistinct. Furthermore, the effect is likely to be bilateral although this is not always true. Nevertheless, it may be said that in the majority of instances the presence of an abnormal sphenoidal fissure indicates a lesion in the vicinity of that fissure and because of this fact this roentgen sign has distinct localizing value.

The sphenoidal fissure deformity has one virtue not possessed by many of the other roentgen manifestations of brain tumor, namely lateralization of the lesion. Frequently the roentgen examination indicates quite definitely the presence of an intracranial neoplasm and may even denote whether the lesion is infra- or supratentorial but fails to indicate whether it is on the right or left side. Often the clincial findings are also deficient in this respect and a ventriculogram or encephalogram becomes necessary. Unilateral sphenoidal fissure deformity in the majority of cases indicates quite definitely the side of the lesion, and air studies are less frequently required in such cases.

To recognize significant changes that occur in the sphenoidal fissure it is necessary that one be familiar with the normal fissure and its variations. It was for the purpose of establishing and classifying these variations that anatomical studies were conducted. As has already been shown there is considerable variation in the appearance of the normal sphenoidal fissure. To become familiar with these it is important that one should carefully scrutinize the sphenoidal fissures in every skull examination. It is only by making this a routine part of the study of such films that one will not overlook changes in the fissures when they occur. Advantage is taken of the fact that in the majority of instances the fissures are symmetrical in a given individual. Thus by comparing one with the other, a significant alteration can readily be detected. One should not, however, lose sight of the fact that in about 9 per cent of cases the fissures are unequal in size and shape. A deformed fissure is usually manifested by an erosion of bone. This erosion is usually due to direct pressure of the lesion upon the bone affected, and usually produces a change either in the shape or size of the fissure (Case 1). While either the lesser or greater wing of the sphenoid or both may be involved, in our experience the lesser wing is the one most commonly affected. Unquestionably, one of the reasons for this is the fact that alteration of the sphenoidal fissure occurs in a large percentage of sphenoidal ridge meningiomas. These tumors straddle the posterior free edge of the floor of the anterior cranial fossa which is comprised of the lesser and greater wings of the sphenoid just above the fissure. Most such meningiomas produce erosive changes in the lesser wing. It is well known that meningiomas often produce a hyperostosis of the bone with which they come in contact. In the case of the sphenoidal ridge meningiomas there may be a hyperostosis of the lesser wing of the sphenoid (Case 11). The marked increased density of the bone bordering the upper edge of the fissure is in striking contrast with the lower edge and also with the density of the opposite lesser wing. This is almost a pathognomonic sign of a sphenoidal ridge meningioma. However, one must not fail to recognize the fact that the so-called benign hyperostosis or hyperostosis frontalis which is of such common occur-

rence may and often does extend down to involve the roof of the orbit and with it the lesser wing of the sphenoid. This condition is nearly always bilateral whereas sphenoidal ridge meningionas are usually unilateral. The hyperostosis of a meningioma may also cause a narrowing of the sphenoidal fissure, which is a much less common finding than a widening or enlargement of the fissure. We have encountered a similar narrowing of the fissure and increased density of the lesser wing of the sphenoid in a case of osteoma of the orbit (Case VI).

At times it is apparent that pressure is being exerted from above since the greatest manifestation of erosion is to be seen in the sphenoidal ridge with fading out as the fissure is reached, which may as a matter of fact be little if at all involved. This type of change is more commonly seen in frontal lobe tumors (Case IV). Since such lesions are often difficult to localize clinically and many produce few if any roentgen manifestations, sphenoidal fissure deformity in such cases is of the utmost value, both from the standpoint of diagnosis as well as the localization and lateralization of the neoplasm.

Bilateral involvement of the fissures is apparently not of uncommon occurrence (8 of 26 cases). This may occur in the presence of a very large frontal lobe tumor which has crossed the midline to involve the opposite side (Fig. 7). The greater degree of involvement of one of the two fissures may indicate the side of origin of the tumor. Bilateral involvement may also be seen in rapidly growing malignant tumors such as a carcinoma of the sphenoid sinus. Such lesions are fairly common and show a tendency to grow forward into the ethmoid and orbital regions giving rise to wholesale destruction of bone (Case V). They are usually accompanied by an exophthalmos with a very marked destruction of the posterior portion of the orbit and disappearance of the sphenoidal fissure on one or both sides. Bilateral involvement of the sphenoid fissures occurred in 2 of 3 cases of pituitary adenomas. In these cases the tumor was of unusually large size. As previously mentioned, in the presence of increased intracranial pressure there may be changes in the sphenoidal fissures and in such cases the condition may be bilateral. In large parasellar meningiomas which extend across the midline there may also be bilateral involvement of the sphenoidal fissures.

Sometimes the change in the sphenoidal fissure consists merely of a demineralization of the bone surrounding the fissure, recognized by comparison with the opposite side. One must analyze such a change very carefully as it may be simulated by certain pathological and technical factors. Swelling of the eyelids or surrounding soft tissues may produce such an appearance; likewise rotation of the head may give rise to the same appearance.

Because of the numerous variations that may occur in the appearance of the sphenoidal fissures and because of the difficulty in many instances of satisfactorily visualizing these structures, one should be extremely conservative in the interpretation of findings. When in doubt additional films should be made with variations in technique in order to demonstrate the fissures to their best advantage. The changes sometimes found are none too definite and become significant only when accompanied by other signs. In the vast majority of cases there will be some alteration in the structure of the sella turcica, or there may be a localized hyperostosis or an alteration in the homolateral optic foramen. Such changes along with a deformed sphenoidal fissure will easily establish the diagnosis and usually the localization of a tumor. Frequently, however, the other changes such as those involving the sella turcica are so slight that one questions their significance. When accompanied by sphenoidal fissure deformity, however, the changes in the sella assume greater importance and will usually result in a positive diagnosis. Only occasionally does one find an alteration of the sphenoidal fissure in the absence of some other roentgen evidence of pathology.

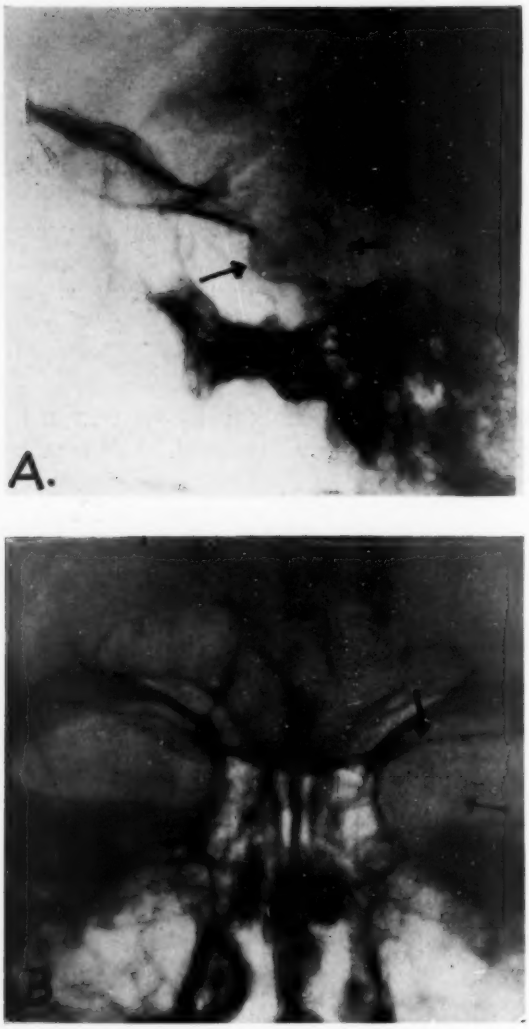


FIG. 3. Case 1. *A*, changes in the sella turcica suggestive of an intracranial tumor. *B*, marked enlargement of the left sphenoidal fissure. Roentgen diagnosis: Left sphenoidal ridge meningioma. At operation: Aneurysm left internal carotid artery.

We have found sphenoidal fissure deformity in several cases in which there was no clinical evidence of either an intracranial or intra-orbital tumor. These are probably instances of normal variations of the fissure. Such findings should be disregarded. We do not believe that a significant deformity of the sphenoidal fissure ever occurs in the absence of clinical manifestations.

Alteration of the sphenoidal fissure is of the same diagnostic significance as deformity of the optic foramen. In our experience deformity of the sphenoidal fissure has been of greater value than changes in the optic foramina and, as a roentgen sign, is possessed of certain distinct advantages. The technique for visualization of the sphenoidal fissures is simpler than that for the optic foramina and requires no special apparatus as is advocated, but not actually needed, for examination of the optic foramina. And, what is more important, changes occur in the sphenoidal fissure in the absence of changes in the optic foramen. The reverse probably occurs but has not been encountered by us.

As in all roentgen interpretation, changes in the sphenoidal fissure should be considered in the light of the clinical aspects of the case. The history will often suggest a parasellar lesion; a sphenoidal ridge meningioma or a tumor so located as might be expected to produce changes in the fissure. In such cases particularly, one must give special attention to these structures. But it is well to make it a routine practice to examine them carefully in every head case, in the same way that one examines the sella turcica and looks for a shift of the pineal body in every skull examination. The effort will be well rewarded as the frequency of sphenoidal fissure deformity is surprising when it is really looked for.

To indicate the value of this roentgen sign a few short case reports are given which will serve to illustrate the type of cases in which this roentgen manifestation of brain tumor has been found useful.

CASE REPORTS

CASE 1. D.W., white, female, aged sixty-one, examined at the Graduate Hospital June 26, 1935. She had had a paralysis of the left sixth cranial nerve since 1930. She complained of pain over the left frontotemporal area daily since November, 1934. This pain radiated into and below the left eye as well as along the left side of the nose. At the onset of this pain she had projectile vomiting which had not recurred. There was a family history of cancer and certain gastrointestinal symptoms which led to the suspicion of cancer in the patient. There was

indigestion with pain in the epigastrium, and bleeding from the bowel, which was quite profuse at times. There was no alteration in bowel habit. She had lost 35 pounds in weight in the last year. She had a hypertension of 195/105.

The neurological examination was negative with the exception of the sixth nerve paralysis.

The roentgen examination of the skull (Fig. 3) was reported as showing changes in the sella turcica very suggestive of a supratentorial tumor. A deformity of the left sphenoidal fissure was not noted at the time. Later when the deformed fissure was found a diagnosis of a left sphenoidal ridge meningioma was made. At operation the lesion proved to be an aneurysm of the left internal carotid artery.

Comment. The sellar changes in this patient were not at all convincing of a brain tumor and because of the patient's hypertension they were at first attributed to pulsations of the internal carotid arteries. Subsequently when the sphenoidal fissure deformity was discovered the sellar changes became more significant and a diagnosis of a sphenoidal ridge meningioma was made. Had it not been for the changes in the left sphenoidal fissure the roentgen examination in this patient would have been of little value. We have had a number of such cases in which the findings in the sphenoidal fissure have been the deciding factor in favor of a diagnosis of brain tumor. This is one of two cases of aneurysm in the middle cranial fossa which gave rise to sphenoidal fissure deformity.

Case II. M.P., white, female, aged thirty-four. Chief complaint, diplopia and ptosis of the left upper eyelid. The patient had had ptosis five years before and during pregnancy which disappeared one week after delivery. She had occasional transient ptosis during the next five years. Diplopia appeared in January, 1937. A year later ptosis returned and had persisted with rapid failure of vision. She had no complaints other than her eyes. Visual fields revealed a right homonymous hemianopsia.

Roentgen Report. Examination of the skull (Fig. 4) shows demineralization and possibly erosion of the dorsum sellae and the left posterior clinoid process. There appears to be some erosion of the left side of the floor of the sella. The anterior clinoids appear normal and the

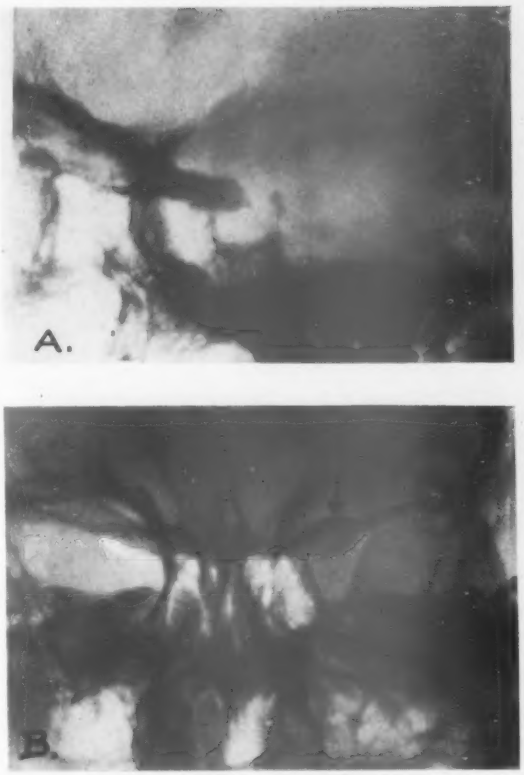


Fig. 4. Case II. *A*, slight but definite changes in the sella turcica. *B*, hyperostosis of the left lesser wing of sphenoid. Roentgen diagnosis: Left sphenoidal ridge meningioma. Confirmed at autopsy.

sella is not increased in size. In the posteroanterior view, we note that the left lesser wing of the sphenoid is broadened and presents a mottled area of increased density. These changes are indicative of a left parasellar space-taking lesion that may be on the basis of a sphenoidal ridge meningioma. The optic foramina are normal in size and essentially normal in contour. There is some haziness of the left orbit which is secondary to the proptosis. *Interpretation:* Left parasellar space-taking lesion which may be on the basis of a sphenoidal ridge meningioma.

At autopsy a left sphenoidal ridge meningioma was found.

Comment. The localized hyperostosis of the lesser wing of the sphenoid on the left side practically established the diagnosis of a sphenoidal ridge meningioma. The sellar changes were not marked and while they suggested the presence of an intracranial

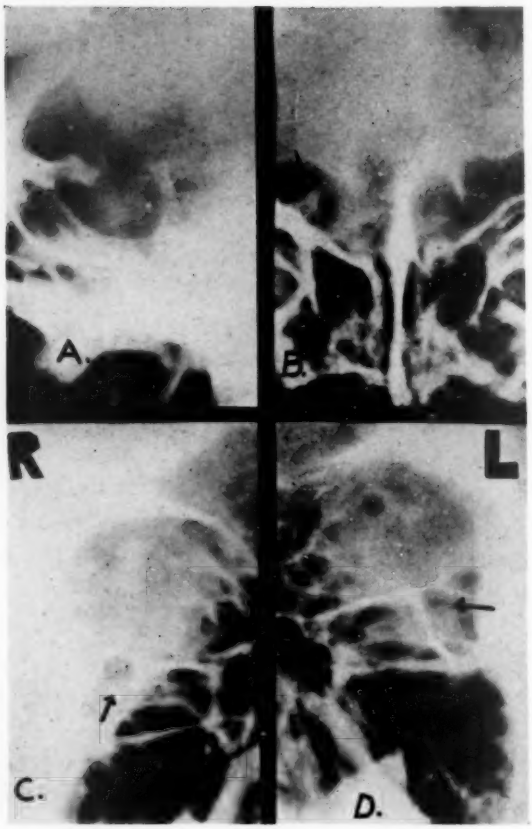


FIG. 5. Case III. *A*, deformity of sella turcica suggesting a pituitary tumor. *B*, complete absence of left anterior clinoid process. *C*, *D*, normal optic foramina.

tumor the changes were, in themselves, not sufficient to indicate the location of the lesion. It is well known that the hyperostosis of a meningioma may be readily confused with the so-called benign hyperostosis which is so common in the frontal region. This latter type of hyperostosis may involve the lesser wing of the sphenoid and we have seen 2 cases in which this presented itself as a diagnostic problem. One of these was very probably a meningioma while the other showing a bilateral hyperostosis of the lesser wings was most probably not neoplastic in origin.

CASE III. B.L., white, female, aged fifty. Chief complaint, disturbance of vision. In March, 1936, the patient suffered from severe headaches which confined her to bed. She became semiconscious and a diagnosis of encephalitis was made. She was treated with roentgen therapy and after about five weeks the headaches gradually disappeared. The patient was then well until one year ago (1940) when she noted failure of vision in the left eye and some impairment in the right. She occasionally had diplopia and headaches. She had no menses for five years prior to her roentgen treatments; then for two years the menses came occasionally and there is occasional spotting. Roentgen studies made five years ago showed definite changes about the sella turcica. The neurological examination was negative. Right disc slightly pale on nasal side. The left disc looked normal. She has a bitemporal hemianopsia.

The roentgen study (Fig. 5) showed a marked enlargement of the pituitary fossa with the typical ballooned-out appearance of a pituitary adenoma. This was at first thought to be the nature of the lesion but further study of the films revealed a distinct unilateral erosion of the sella with complete absence of the left anterior clinoid process and a definite deformity of the left sphenoidal fissure (Fig. 6). In view of these findings it was thought that a parasellar lesion such as a sphenoidal ridge meningioma or an aneurysm was the most likely possibility. The long, slowly progressive history and the absence of pituitary symptoms or stigmata finally led to the conclusion that the patient did not have a pituitary adenoma in spite of the almost pathognomonic alteration of the sella turcica.

This patient is awaiting operation.

Comment. This case illustrates well the

FIG. 6. Case III. Marked enlargement of left sphenoidal fissure and erosion of lesser wing. Roentgen diagnosis: Left sphenoidal ridge meningioma or aneurysm. Patient awaiting operation.

diagnostic difficulties encountered in tumors about the sella turcica. Had it not been for the sphenoidal fissure deformity in this case the roentgen diagnosis would have been unqualifiedly a pituitary adenoma. Sphenoidal fissure deformity does not exclude a hypophyseal tumor since 3 of 10 such tumors included in the series listed in Table v showed deformity of the sphenoidal fissure. However, sphenoidal fissure deformity is not the rule in tumors of the pituitary. The necessity of correlating the clinical with the roentgenological findings is also well brought out in this case.

Case iv. O.P., white, female, aged forty-six, admitted to Jefferson Hospital with an eight year history of personality change, memory defect and a recent history of gait disturbance and incontinence. Neurological examination elicited some nasal blurring of the right optic disc, coarse tremors of the fingers, gait disturbance, hyperactive reflexes and loss of vibration sense in the feet.

Roentgen Report. Examination of the skull (Fig. 7) shows a bilateral destruction of the sphenoidal fissures which is highly suggestive of a frontal lobe space-taking lesion. The sella turcica is normal in size and contour but rather demineralized and presents an appearance which could be the result of pressure. There is no evidence of increased intracranial pressure and a calcified pineal is in its normal midline position. *Interpretation:* Examination of the skull shows a bilateral erosion of the sphenoidal fissures suggestive of a frontal lobe space-taking lesion.

At operation a large interventricular tumor was found arising in the posterior portion of the left frontal lobe and extending across the midline. Histopathologically this was an astrocytoma.

Comment. This case is an excellent example of the value of sphenoidal fissure deformity since this finding was the only roentgen evidence of a brain tumor in this patient. Combined with the clinical history of progressive personality change the diagnosis of a frontal lobe tumor was relatively easy. The fact that the fissures were bilaterally involved indicated that the tumor was of considerable size and had extended

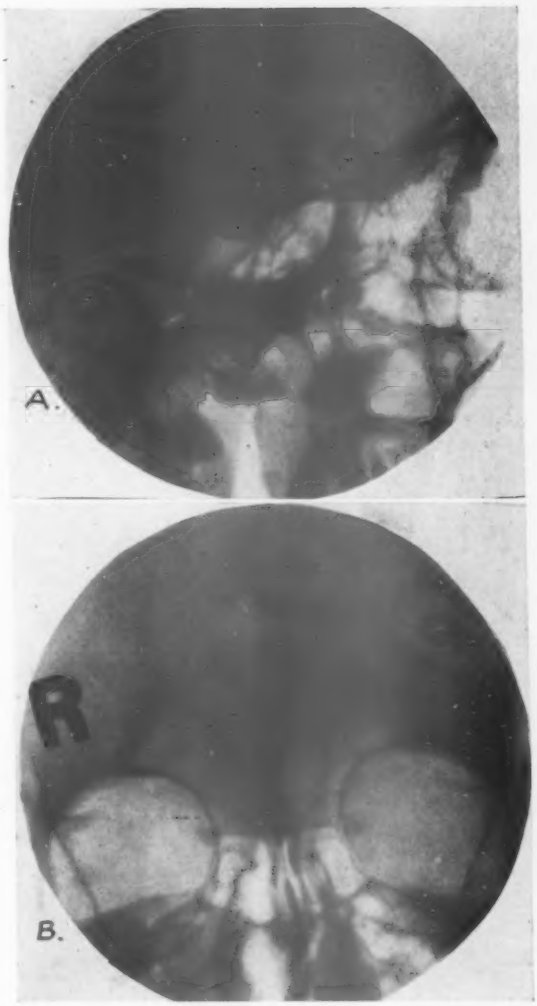
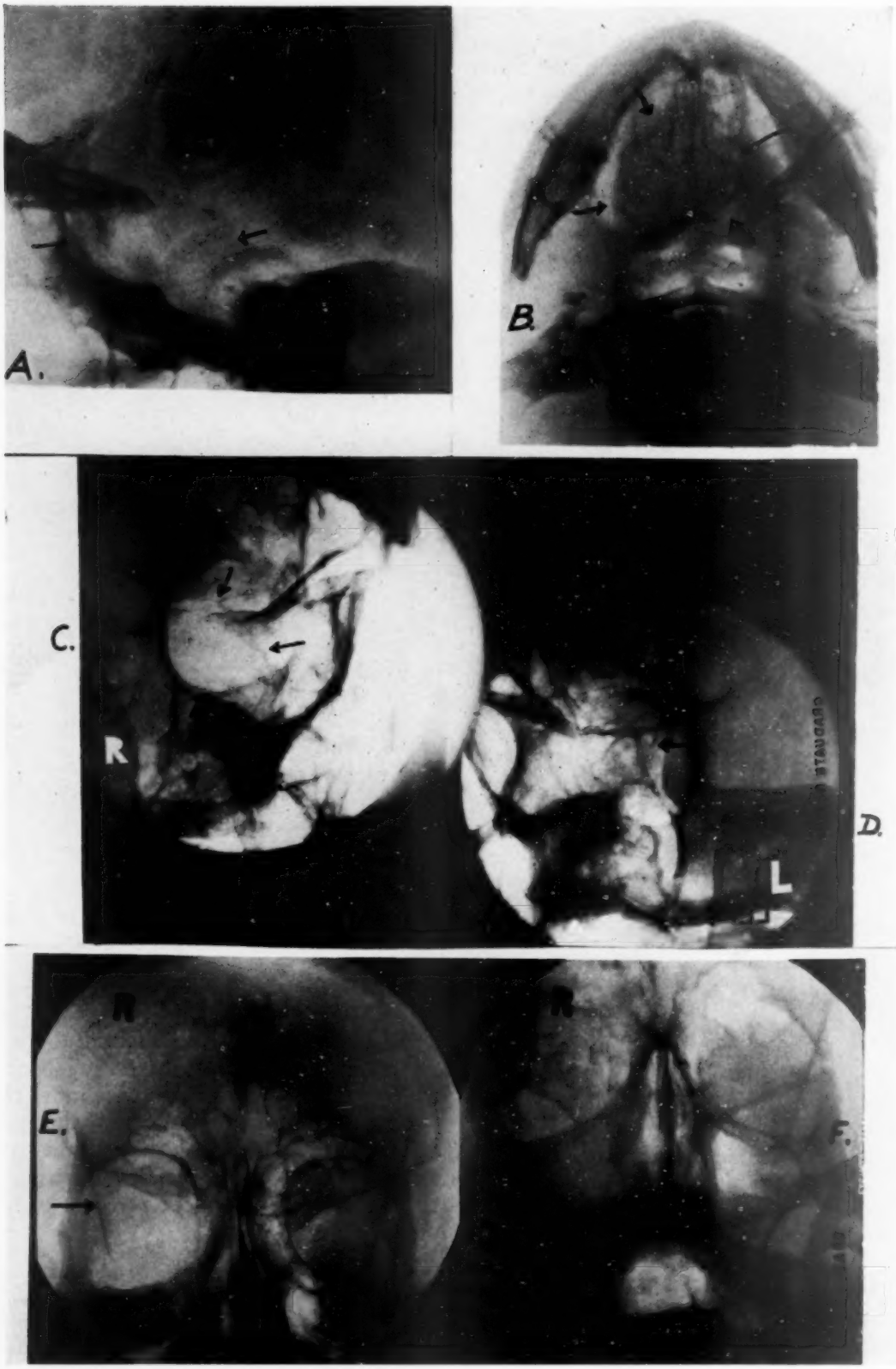


Fig. 7. Case iv. *A*, slight changes in sella turcica not diagnostic of a brain tumor. *B*, marked bilateral deformity of the sphenoidal fissures due to a frontal lobe tumor. At operation: Large astrocytoma left frontal lobe extending to opposite side.

across the midline as was found at operation.The absence of roentgen evidence of increased intracranial pressure, that is convolutional atrophy, indicated that the bilateral sphenoidal fissure deformity was not the result of generalized thinning of the bones as is seen in the presence of convolutional atrophy.

Case v. F.E., white, female, aged fifty-one, was examined at the Graduate Hospital in November, 1937. In June of that year the patient's vision in the right eye began to fail and


A.
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the eyeball became more prominent. Later the eyelid on the right side began to droop and vision in the left eye diminished progressively until at present she distinguishes light and form and movement. For several weeks she had attacks of sharp pain over the right side of her face and head which disappeared after a tonsillectomy nine weeks ago. There is exophthalmos, ptosis on the right, internal and external exophthalmoplegia on the right. Bilateral optic nerve atrophy. No papilledema.

The roentgenographic examination (Fig. 8) showed an extensive destruction in the region of the posterior paranasal sinuses and middle fossa on the right side. The sella turcica with the exception of the anterior clinoid processes was nearly completely destroyed. There was an absence of the sphenoidal fissure on the right side and a marked erosion of the posterior, lateral and medial walls of the orbit. The right ethmoid and maxillary sinuses were markedly clouded evidently due to direct involvement or interference with drainage. In the base view there could be seen a large soft tissue tumor occupying the sphenoid sinus region and a loss of bone detail in the floor of the right middle fossa. While there is some involvement in the left middle fossa, this is less than is seen on the right side. Special views made of the optic foramina showed complete absence of the foramen on the right side and erosion of the inferior edge of the left foramen. While there were a number of diagnostic possibilities to be considered, the most likely appeared to be an extensive carcinoma most probably arising in the sphenoid sinus. A chordoma or meningioma seemed to be less likely possibilities.

Biopsy revealed a carcinoma arising from the sphenoid sinus.

Comment. This is a fairly common cause for sphenoidal fissure involvement. Cancer of the paranasal sinuses frequently invades the orbit producing extensive bone destruction. Another case in this series caused bilateral sphenoidal fissure involvement.

Case vi. J.V., white, male, aged forty-nine, was examined at the Graduate Hospital. Three years before, the patient first noted a slight bulging of his right eye which had persisted to date. The eye appeared more prominent on arising in the morning than in the late afternoon. There was no disturbance in vision and no pain. There was some injection of the conjunctival vessels. Aside from the right eye the physical examination was negative.

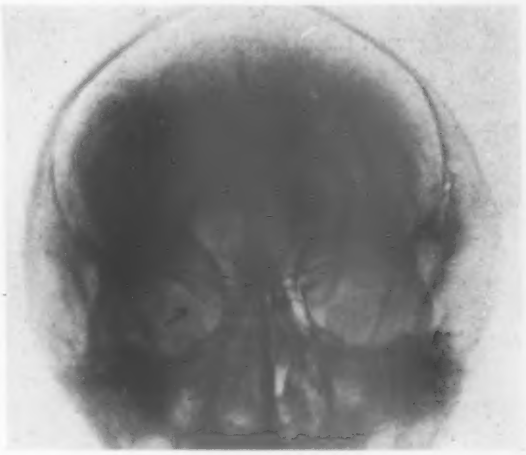

Fig. 9. Case vi. Narrowing of right sphenoidal fissure with increased density of lesser wing due to an osteoma of the lesser wing of sphenoid.

The patient was referred for a roentgen examination of the right orbit with a clinical diagnosis of an orbital tumor. Both orbits were examined including the optic foramina. The foramina were negative. The right sphenoidal fissure was definitely narrowed and the lesser wing increased in density as compared with the left side (Fig. 9). A roentgen diagnosis of a sphenoidal ridge meningioma was made. A complete neurological examination was negative, as was also an encephalographic study.

An operation was performed and the right anterior and middle cranial fossae were searched for a tumor. Nothing was found. A portion of the roof of the right orbit was removed and a small osteoma was found involving the lesser wing of the sphenoid with encroachment upon the sphenoidal fissure. The tumor was removed with subsequent relief of the patient's symptoms.

Fig. 8. Case v. *A*, extensive destruction of sella turcica and neighboring structures; *B*, large soft tissue tumor mass in region of sphenoid sinuses; *C*, complete absence of right optic foramen; *D*, erosion lower edge left optic foramen; *E*, absence of sphenoidal fissure on right; *F*, marked clouding right antrum due to direct involvement or defective drainage. Roentgen diagnosis: Carcinoma of the sphenoid sinus. Confirmed by biopsy.

Comment. This case illustrates the fact that sphenoid fissure deformity occurs with orbital tumors as well as those within the intracranial cavity and this possibility should not be overlooked. Another case in this series was an osteoblastic metastatic cancer from the prostate involving the orbit with sphenoidal fissure deformity.

SUMMARY

In this communication attention is directed to the value of alterations in the appearance of the sphenoidal fissures as a roentgen manifestation of an intracranial or intraorbital tumor. Because of the variations in the appearance of this fissure an anatomical and roentgenological study was made of a series of normal skulls. As a result of this study six distinct types of fissures are described as occurring normally.

Special emphasis is placed upon the importance of proper roentgenographic technique. A technique for showing the sphenoidal fissures to their best advantage is described.

The various types of deformity of the sphenoidal fissure as well as the particular intracranial and intraorbital tumors commonly producing these changes are discussed.

Six case reports are included which serve to illustrate various phases of this subject.

DISCUSSION

DR. VINCENT C. JOHNSON, Ann Arbor, Mich. In this excellent paper Dr. Kornblum and Dr. Kennedy have presented the results of their careful study of two fissures which we have all observed in frontal sagittal roentgenograms of the skull.

When examining roentgenograms of this type it is always advisable to carefully compare symmetrical structures located in each half of the skull, as the petrous portions of the temporal bone, the sphenoid ridges, and, as Dr. Kornblum suggests, the sphenoidal fissures.

Numerous papers describing alterations of the symmetrical appearance of the petrous ridges and sphenoid ridges resulting from developmental variations or adjacent lesions have appeared in the literature, but very little attention has been paid to the sphenoidal fissures.

We have also found that it is difficult to obtain sharp definition of these fissures in frontal roentgenograms of some normal skulls. Instances of asymmetrical lack of sharp delineation may be very confusing and even though it is difficult to obtain exactly similar right and left oblique frontal projections, these views may frequently aid in determining whether or not local bone destruction or proliferation has occurred adjacent to these fissures.

Incidentally, the paper which Dr. Kornblum submitted to me is far more complete and discussed this subject in more detail than he had time to present here. From one of his tables it is surprising to learn that 18 of a group of 75 verified brain tumors produced changes in the roentgen appearance of the sphenoidal fissure on the right side of the lesion. These unilateral changes were caused in some instances by tumors remote from the locality of the sphenoidal fissure. This finding brings me to the conclusion that we have been overlooking slight alterations which Dr. Kornblum has learned to recognize from his careful survey.

Since my attention has been called to the results of this work, I have altered our routine skull examination so that now we acquire better visualization of the posterior wall of the orbit in each frontal projection.

Recently a boy, aged seventeen, complaining of a pulsating left exophthalmus was referred to our roentgen department for examination of the skull. Frontal views revealed definite erosion of the left sphenoidal fissure, which was confirmed in oblique frontal projections. This information alone might have led to a correct diagnosis; however, a left internal carotid arteriogram was obtained and this additional examination revealed an arteriovenous communication with the cavernous sinus and marked dilatation of the left ophthalmic vein, which enters the orbit by way of the superior orbital or sphenoidal fissure, explaining the localized erosion and also the pulsating exophthalmus.

Careful examination of each pair of sphenoidal fissures seen in every routine skull examination should result in gaining more information that will aid in localizing intracranial and intra-orbital lesions.

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CALCIFICATION OF THE VAS DEFERENS*

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SEVEN cases of calcification of the vas deferens have been seen in the New England Deaconess Hospital during the past two years. Our first and most striking case was seen in August, 1939, and although histological proof of the findings in that case was never obtained, the course of the shadows cast by the calcification was such as to preclude any other diagnosis. A cursory search of the American roentgenological and urological journals and textbooks at that time revealed no mention of the subject. The original films were shown to a number of physicians actively engaged in those two specialties, but almost none could recall having previously seen the condition. Additional cases were soon found and several of these were histologically proved. A more careful search of the literature has shown earlier reports of calcification in the vasa deferentia and their ampullae and in the seminal vesicles. From these reports it appears that calcification may be found in the ampulla of the vas without being present in the remainder of the duct.

Calcification in the vas deferens may be associated with calcification in the seminal vesicles, as in the case of Chiari,[1] or it may be present in the vesicles without being found in the vas deferens, as in the case of George.[3] This latter condition is perhaps not analogous to calcification within the vas deferens since the two structures serve different functions and since the seminal vesicles are more frequently the seat of chronic infection.

The first pathological report of calcification of the vas deferens is apparently that of Duplay[2] in 1855 and the first reported case in which the process was demonstrated roentgenologically is that of Hofer and Lossen[4] in 1932. Perhaps the most comprehensive article on the subject up to the present time is that of Janker.[5] A total of 13 additional cases has been reported but it is our belief that this low figure does not represent the true incidence of the condition. Calcification of only segments of the ducts might easily be misinterpreted on conventional films of the abdomen or pelvis unless the portion calcified should happen to be in the region of the ampulla, where the course of the duct is unlike that of any artery normally occurring in the male. If the film includes the scrotum and if the calcification is in the scrotal portion of the vas deferens the diagnosis is obvious, since the vas pursues a relatively smooth course and its lumen is greater than that of the arteries in this region. The condition has undoubtedly been overlooked at the autopsy table since the pathologist is usually not much interested in the condition of the vasa deferentia and since they are normally firm, cord-like structures in the elderly man.

Of the 16 cases reported in the literature 13 are presumably on the basis of degenerative processes since they occurred in elderly men without other obvious cause. Three are apparently the result of tuberculosis or other chronic inflammatory disease. There is no history of diabetes in the reported cases.

Of our 7 cases, 4 occurred in diabetics and all of these showed evidence of considerable calcification of the arteries. In several cases the degree of arterial calcification was even greater than that usually seen in diabetes and since none of these patients gave any definite history of infection of the genital tract we have been led to associate the process in the vasa deferentia with the degenerative process in the arteries. Case 11 gave a definite history of repeated attacks of gonorrhea and we therefore assume that the calcification of the vas deferens in this patient was due to

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FIG. 1. Case 1. *A*, conventional film of the abdomen showing the calcified vasa deferentia along the posterior and lateral walls of the pelvis. Note the points where they cross the lower ureters. *B*, regional film showing calcification throughout the course of both vasa.

the inflammatory process. No operative procedure was carried out on this patient and histopathological studies are therefore not available.

In Case 1 of our series the calcification was present throughout the course of both ducts, as shown in Figure 1. The shadows cast by the calcification in the intrapelvic portions of the ducts were first seen in films taken in the course of intravenous pyelography. Subsequent films to include the scrotum were then taken and showed that the entire course of both ducts was heavily calcified. This is the only case which we have seen in which there was calcification in considerable amount *throughout* the course of both ducts. In 2 cases the calcification was most dense in the intrapelvic portions of the ducts but was present in lesser amounts in those portions of the ducts which lay in the inguinal canal. In 2 cases calcification of sufficient degree to show roentgenologically was present only in the pelvic portions of the ducts, and in 1 case it was evident only in the extra-abdominal portions. In these latter cases the diagnosis was suspected when double, parallel lines of calcium density were seen to cross the obturator foramen obliquely, downward and medially. Additional regional films were then taken to demonstrate the further course of these shadows. In 1 case, on whom roentgen examination was not done, the calcification was seen in histopathological sections by our pathologist, Dr. Shields Warren.

In conventional films of the abdomen or pelvis the shadows cast by calcification in that portion of the ductus deferens which lies within the inguinal canal form double parallel lines which cross the shadow of the obturator foramen in an oblique line which runs downward and medially. Linear shadows in this region must therefore make one suspect calcification in the vas deferens, but it must be noted that the shadows cast by a calcified internal pudendal artery pursue the same course for a short distance.

If the arterial calcification is extensive it may be noted that the internal pudendal artery originates from the internal iliac artery in the lateral portion of the pelvis and that after crossing the shadow of the obturator foramen it courses medially to supply the tissues about the anus and the root of the penis. The course of the vas deferens within the pelvis is unlike that of any artery in the male but is similar to that of the ovarian artery in the female, from which fact no difficulty should arise. It is of some interest that in each of our cases in which the intrapelvic portion of the vas deferens was calcified, the point at which it arched over the ureter is clearly shown by an accentuation of the shadow. This arching of the duct over the ureter is a prominent feature in its course along the posterior and lateral walls of the pelvis and is clearly shown in all anatomical texts.

REPORT OF CASES

Case I (PMH 39:1202). Dentist, aged forty-four, married and had one child who was eleven years of age. Mild diabetes for five years with history of progressive loss of vision to complete blindness with recent renal and cardiac decompensation. Roentgen examination showed calcification of both vasa deferentia throughout their courses (Fig. 1). Examination by consultant in urology showed bilateral thickening of the epididymis and vas deferens; testes were soft and of slightly less than normal size. Died in December, 1939, four months after studies in hospital. Permission for autopsy not obtained.

Fig. 2. Case II. Calcification in those portions of the vasa lying medial to the ureters.

Fig. 3. Histological section of spermatic cord showing calcification within the thick, muscular wall of the vas deferens.

Case II (PMH 39:1542). Druggist, aged thirty-six, not married. Non-diabetic. Had a chronic duodenal ulcer which was inactive at time of study in this hospital. Gave history of repeated attacks of gonorrhea and examination showed chronic prostatitis. No evidence of syphilis. Roentgen examination showed calcification of those portions of the vasa deferentia lying medial to the course of the ureters (Fig. 2).

Case III (PMH 39:1873). Hotel proprietor, aged sixty. Was married twice and had eight children, four of whom are living and well; one died of influenza, one of diphtheria, one was stillborn, one lived only few hours. Had had diabetes about fifteen years and was taking 30–40 units of insulin daily. Admitted to hospital because of right hydrocele with old hemorrhage. Roentgen examination of the pelvis and scrotum prior to operation in November, 1939, showed calcification in moderate amount in the intrapelvic portions of the vasa deferentia and to a lesser degree in the inguinal portion of the

one on the right side. Histopathological examination of the operative specimen showed clearly the calcification within the muscular wall of the vas (Fig. 3). A film taken seventeen months later showed calcification in moderate amount

FIG. 4. Case IV. Calcification in the extra-abdominal portions of the vasa deferentia.

throughout the course of the remaining left vas deferens.

CASE IV (PMH 31:1438). Laborer, aged thirty, not married. Had had diabetes for twelve years but this had been very poorly controlled during past six years. Admitted to hospital because of badly infected foot, during which time he required about 60 units of insulin daily with diet of 1,600 calories. Roentgen examination showed marked calcification of the arteries of the pelvis and lower extremities. Both vasa deferentia were heavily calcified in their extrapelvic portions (Fig. 4).

CASE V. Clerk, aged fifty-nine. Admitted to another hospital because of prostatic calculi and a diverticulum of the prostatic urethra. Was operated upon and histopathological examination of the tissues by Dr. Shields Warren showed calcification in the vas deferens.

CASE VI (PMH 40: 267). Laborer, aged sixty-eight. Married twice, no living children. Hinton test negative. Admitted to hospital because of urinary retention due to prostatic hypertrophy. Roentgen examination showed calcification in moderate amount in the intrapelvic and inguinal portions of the vasa deferentia.

CASE VII (NEDH 96, 134). A retired railroad section foreman, aged sixty-six. Was married and had had three children, whose ages were forty-three, forty-one and thirty-seven years. Mild diabetes for eighteen years. Roentgen examination showed an extreme degree of arterial calcification. Considerable calcification was seen in the intrapelvic portions of both vasa deferentia on the antemortem films, and on postmortem films small amounts were also seen

FIG. 5. Female, aged fifty-three. Extensive arterial calcification including the ovarian and internal pudendal arteries.

in the extrapelvic portions of the ducts. Death due to pneumococcus septicemia. Autopsy confirmed finding of calcification in the vasa.

SUMMARY

Seven cases of calcification within the walls of the vas deferens have recently been

seen and their histories are briefly summarized. In four cases, the process was associated with extensive arterial calcification occurring in diabetics and was presumed to be the result of degenerative changes. One additional case occurred in an elderly man with obvious vascular disease but without a definite history of infection of the genital tract. In one case the calcification was thought to be due to a chronic inflammatory process.

Attention is called to the fact that calcification in the vas deferens may be confused with that occurring in the internal pudendal artery unless the process is extensive, in which event the course of either vessel is obvious.

Addendum: Two additional cases have been seen since the paper was submitted for publication. One patient was a man, aged sixty-nine, who had had diabetes for twenty-one years and who had extensive vascular disease. The other was a man, aged seventy-two, who had had diabetes for one year.

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ATELECTASIS FOLLOWING PNEUMONIA IN CHILDREN*

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IT IS well known that exudate in the bronchi following pneumonia may cause bronchial obstruction and that bronchial obstruction may be responsible for atelectasis. This type of obstruction occurs in adults[4] as well as in children, although it might be expected to occur most frequently in early life when the bronchi are smaller and therefore more readily obstructed. Considerable emphasis has been placed on the rôle of combined infection and bronchial obstruction with secondary atelectasis in the development of bronchiectasis.[1,2,3,7] Less emphasis has been placed on the frequency of atelectasis and its spontaneous clearing following pneumonia in children.

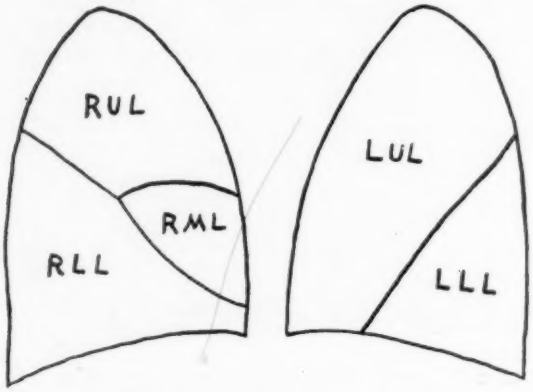

FIG. 1. Diagram showing the usual locations of the interlobar septa as projected in the straight lateral chest films. Only segments of the septa which lie in the plane of the roentgen-ray beam are seen in these views.

During 1939, 135 patients with the clinical and roentgenological findings of pneumonia were examined in the Department of Roentgenology of The Infants' and The Children's Hospitals. In this group, 26 instances of atelectasis were observed (19 per cent). This communication will deal principally with the findings in these 26 patients with atelectasis.

Clinically, all of these patients had the signs and symptoms of pneumonia. Pneumococci were cultured from the throats of 15 patients, hemolytic streptococci from 2, and *Haemophilus influenzae* from one. Eight patients had no cultures taken. The ages of the patients ranged from three weeks to ten years ten months. Seventeen of the group were under two years of age. The duration of acute illness at the time of the first roentgenological examination varied from two days to two weeks with an average illness of five days.

The roentgenological signs of atelectasis are well established.[5,6,8] They consist essentially of an increase in density of the involved lung tissue accompanied by alterations in the normal relationships of the shadows in the region of involvement which indicate that a decrease in normal volume has occurred.

In addition to increased density of the involved lung, three roentgenological signs of atelectasis were observed:

1. Displacement of the heart and mediastinum toward the area of increased density, sometimes accompanied by narrowing of the interspaces between the ribs, elevation of the diaphragm on the involved side, and emphysema of adjacent portions of the lung (Fig. 2).

These findings were observed in the posteroanterior view in 9 patients (35 per cent).

2. Displacement and curving of an interlobar septum toward the area of increased density (Fig. 2, 3 and 4).

This sign was observed in 24 patients,

* From the Department of Roentgenology of The Infants' and The Children's Hospitals, Boston. Read at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.
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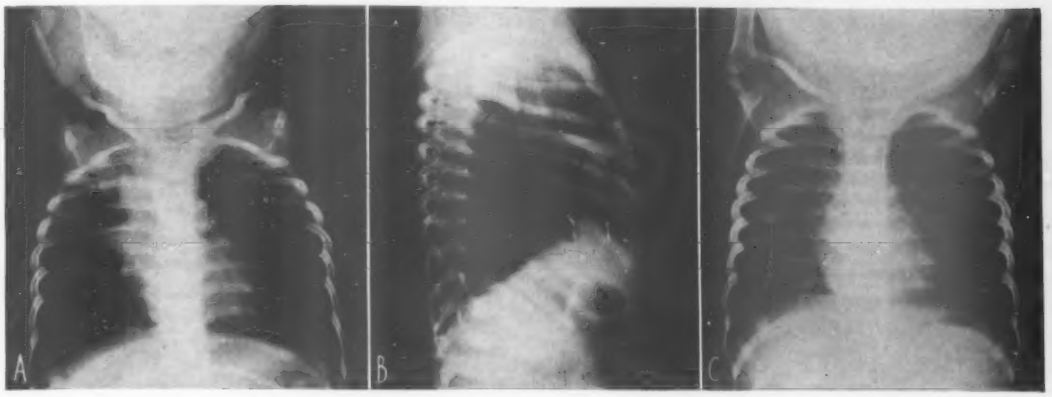

Fig. 2. Pneumonia. Patient aged thirteen months. Acutely ill for two days. Temperature 103°F., rapid respirations and physical signs of bronchopneumonia. *A*, posteroanterior view shows dense irregularly mottled shadows in the right apex and at the right hilum. The mediastinum is displaced to the right. *B*, lateral view shows two areas of atelectasis, one of the right middle lobe, and the other of the posterior apical segment of the right upper lobe. They are seen in this view as dense triangular shadows with their apices pointing toward the hilum. *C*, posteroanterior view of the same case two days later. Almost complete clearing has taken place. The patient was clinically well.

usually on the lateral film (92 per cent).

3. Close spacing of large bronchovascular markings to form a curvilinear triangle of increased density within a lobe, with the base of the triangle at the periphery, its apex directed toward the hilum, and any curve of its sides toward the inner aspect of the triangle (Fig. 2 and 4).

This triangular shadow within a lobe was observed in 6 patients (23 per cent), and

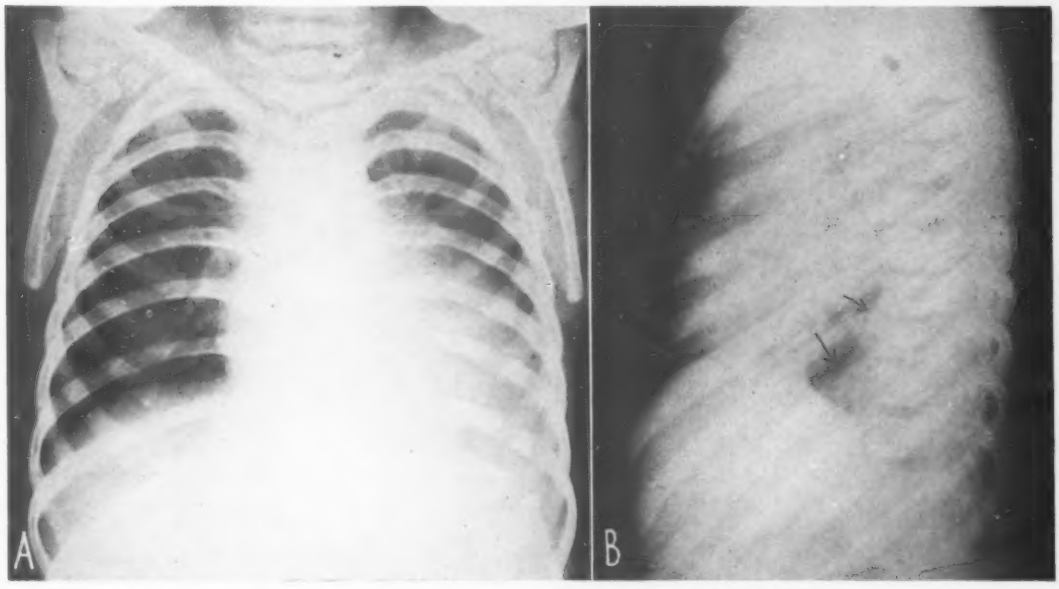

Fig. 3. Pneumonia. Patient aged four years two months. Acutely ill three days. Temperature 104F°. Rapid respiration, dullness and bronchial breathing at the left base. *A*, posteroanterior view shows dense cloudiness extending from the left hilum throughout the left base. *B*, lateral view shows cloudy area to be located posteriorly and limited sharply by the interlobar septum which is curved toward dense area indicating partial atelectasis of the left lower lobe in the presence of considerable infiltration. Both the infiltration and the atelectasis cleared in one week under sulfapyridine therapy.

was interpreted as atelectasis involving one or more bronchopulmonary segments of the lobe.[8] The curved side of the triangle was usually formed by a subjacent interlobar septum.

The one single finding which was constant in all patients was that of increased density of the lung in the involved area. Displacement of the mediastinum and other structures adjacent to the atelectatic area occurred in the presence of atelectasis which involved a considerable area of previously air containing lung. Such a degree of collapse could obviously not occur in the presence of a large amount of exudate or infiltration in the involved lung (Fig. 3).

Lateral or oblique films of the chest were necessary in order to detect atelectasis which did not displace the heart and mediastinum, or cause narrowing of the interspaces or elevation of the diaphragm. Lateral views were taken routinely on all patients. It was felt that establishment of this routine procedure was desirable in

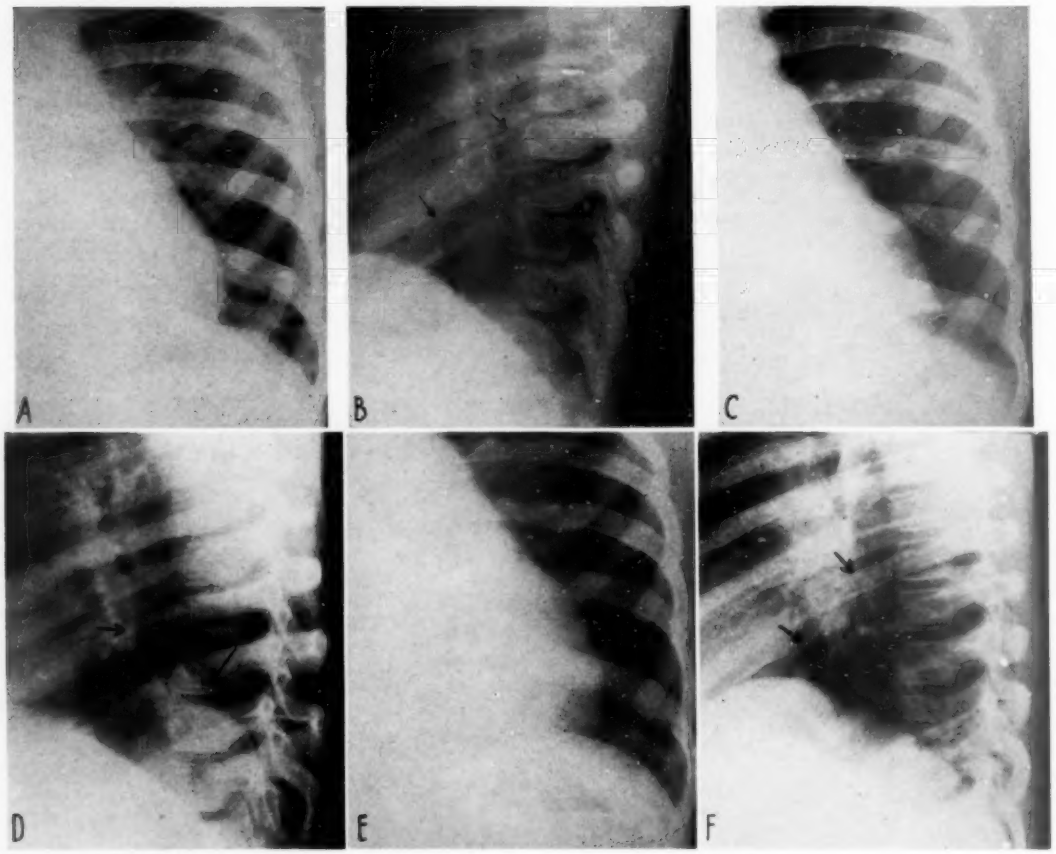

FIG. 4. Pneumonia. Patient aged ten years two months. Clinical course of left lower lobe pneumonia with crisis six days before the first roentgenological examination.

A, posteroanterior and *B*, left lateral views show infiltration consistent with resolving pneumonia. The interlobar septum is well shown in the lateral view, is slightly thickened and occupies the usual position, forming a straight line in this projection. *C*, *D*, re-examination six days after *A*, *B* following acute pain in the left side of the chest, and cough. There is an increase in the density of the shadow at the left base and slight pleural thickening. The lateral view shows posterior displacement and curving of the interlobar septum toward a triangular area of partial atelectasis which involves the basal segments of the left lower lobe.

E, *F*, re-examination three days after *C*, *D* shows almost complete clearing of the infiltration. The septum is again in normal position. Patient was clinically well. Subsequent films showed no remaining abnormality

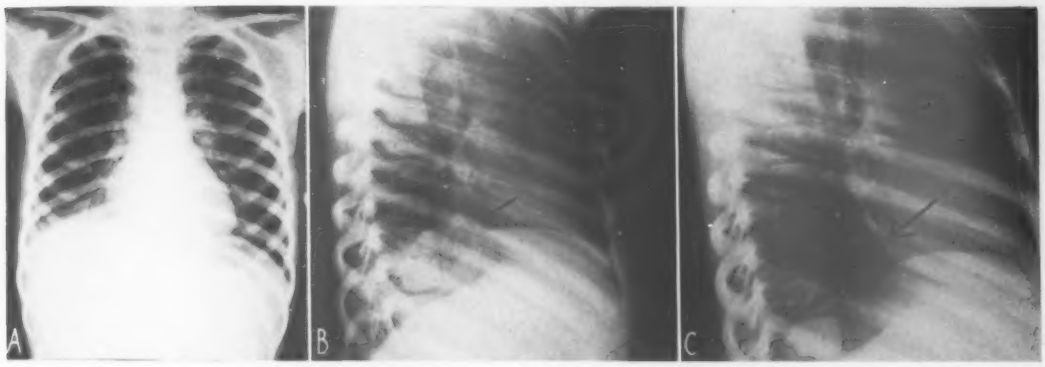

Fig. 5. Foreign body. Patient aged seven years. No history of foreign body aspiration, Headache, cough, and loss of appetite for several weeks. Physical examination revealed redness of the throat and tonsils, and dullness and suppression of breath sounds at the right base. *A*, posteroanterior view shows an area of increased density extending from the lower portion of the right hilum across the base. *B*, lateral view of *A* shows changes similar to those shown in Figure 3*B*. *C*, re-examination two weeks later shows partial clearing of the previous atelectasis. Patient was clinically improved and physical signs were less pronounced.

Two days after the second examination, the patient coughed up a fragment of a peanut which was coated with green, mucopurulent exudate. A history of choking while eating peanuts two months previously was obtained only after careful questioning. Recovery was complete and bronchoscopy and lipiodol bronchograms revealed no remaining foreign body or bronchiectasis.

order to have comparative views rather than to rely entirely on roentgenoscopic localization and various oblique films which could not be so readily duplicated, although such films were taken when considered necessary in the course of the examination. In most instances, it was possible to recognize the interlobar septa in the lateral view, and the locations of these septa were found to be of great value in determining the amount of space occupied by the individual lobes. It is recognized that the lateral projection usually shows only a segment of each septum. Nevertheless, these segments were remarkably constant in their locations as seen in the lateral view (Fig. 1). In the majority of instances, subsequent films showed a definite return of the septa to their usual locations following clearing of the atelectasis (Fig. 4). The only septum which can usually be seen in the posteroanterior projection is that of the fissure between the right upper and middle lobes. Delineation of this septum in the posteroanterior view was, however, not as constant as was its demonstration in the lateral view.

In some patients, the atelectasis as seen in the lateral views provided an explanation for clinical symptoms which were not consistent with the apparent dense infiltration observed in the posteroanterior film. In other patients, the recognition of atelectasis offered an explanation of symptoms which would otherwise have been interpreted as recurrence of the pneumonic process (Fig. 4).

Treatment of these 26 patients was symptomatic, accompanied by chemotherapy in 10 instances. Clinical recovery was uneventful with the exception of 2 patients, one of whom required bronchoscopic aspiration of retained secretions and another who developed empyema. Of the remaining 24 patients, 20 were followed both clinically and roentgenologically to complete clearing of the pneumonia and the atelectasis. Disappearance of the atelectasis usually took place in from one to two weeks. In 4 patients the roentgenological follow-up was not complete although clinical recovery was satisfactory and partial clearing of the atelectasis had taken place at the time of discharge from the hospital.

Even though 20 of the 22 patients who

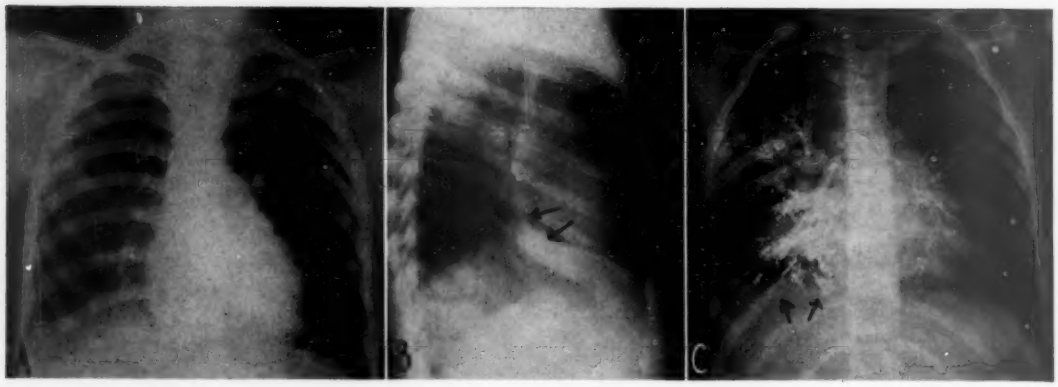

Fig. 6. Bronchiectasis. Patient aged ten years. Clinical history of "bronchitis" about two months before examination, followed by productive cough and loss of weight. Physical examination revealed dullness and coarse râles at the right base.

A, posteroanterior view shows a dense, well defined shadow extending from the right hilum to the lateral portion of the base.

B, lateral view shows a triangular shadow of increased density with one side formed by the displaced interlobar septum and the apex directed toward the hilum.

The roentgenological changes in this case are similar to those shown in Figures 4 and 5. The patient improved clinically but the roentgen appearance remained the same.

C, lipiodol bronchogram two weeks after *A* and *B* shows slight but definite bronchiectasis in the atelectatic area. Bronchoscopy revealed no visible abnormality.

were completely followed in this series had clinical and roentgenological recoveries, it is felt that all patients with atelectasis should be followed roentgenologically to complete clearing or given the benefit of bronchoscopy if the atelectasis persists for longer than two or three weeks. This is especially important when the atelectasis is present at the first examination as was the case in all but 3 of these patients. When atelectasis is present, it is frequently impossible to determine whether or not this portion of the lung was involved before the onset of acute illness. The clinical signs in bronchiectasis are sometimes misleading. Frequently, a history of foreign body aspiration is very difficult to obtain. Roentgenologically, the signs produced by the foreign body or accompanying bronchiectasis cannot be distinguished from those seen following pneumonia. This is well illustrated by 2 instances which are shown here (Fig. 5 and 6).

Because of these cases and others which were very similar each patient with atelectasis has been considered as a possible case of foreign body aspiration or bronchiectasis in spite of clinical history and symptoms which might point to the contrary.

SUMMARY

1. Atelectasis frequently occurs secondary to pneumonia in children.

2. This atelectasis may involve all or only part of one or more lobes in the lung.

3. Increased density of the involved lung and three additional signs of atelectasis were seen in this series as follows:

(a) Increased density in the lung with displacement of adjacent structures toward the collapsed area as seen in the posteroanterior view.

(b) Diminution in size of a lobe of the lung as shown by displacement of the interlobar septa toward an area of increased density.

(c) A curvilinear triangle of increased density comprised of large closely spaced markings with the apex of the triangle pointing to the hilum indicating atelectasis of one or more bronchopulmonary segments within a lobe.

4. Lateral views of the chest were very

valuable in the detection of small areas of atelectasis.

5. The atelectasis following pneumonia cleared completely in all of the patients of this series who were followed.

6. Atelectasis following pneumonia could not be distinguished roentgenologically from that seen in the presence of foreign body or bronchiectasis.

7. All cases of atelectasis should be followed roentgenologically to complete clearing because of the ever present possibility of foreign body or bronchiectasis.

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ABSENCE OF THE HILAR SHADOW

A DIAGNOSTIC SIGN IN RARE CONGENITAL CARDIAC MALFORMATIONS (TRUNCUS ARTERIOSUS SOLITARIUS WITH HETEROTOPIC PULMONARY BLOOD SUPPLY)

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EXACT roentgen diagnosis of the presence and the type of a cardiac anomaly is a field in which the percentage of failures is still distressingly high. Therefore every observation which may enable us to identify some cases in this large group is worthy of careful evaluation. In the case of right-sided solitary truncus aorticus reported here we re-examined the roentgenogram after the anomaly had been clarified at autopsy and we believe that the exact detailed diagnosis could have been made if all roentgenographic signs had been carefully analyzed.

REPORT OF CASE

A female child developed a moderate cyanosis shortly following a normal delivery. This increased in intensity during the feedings. The heart did not present any pathologic findings on physical examination. Tentative diagnoses of thymic enlargement or congential pulmonary atelectasis were made. A roentgenogram taken at this time showed well aerated lungs and a triangular shadow in the left upper mediastinum compatible with a moderate enlargement of the thymus. During the five months of the child's life span the cyanosis gradually increased, particularly on crying, and the infant showed unsatisfactory gain in weight. Five months and eight days after its birth the infant died. At no time were there any heart murmurs audible. A roentgenogram taken two days before the child's death presented definite evidence of cardiac involvement (Fig. 2). The heart was enlarged and the aortic knob was very prominent. In the place of a pulmonary arch there was a deep incisura. The left lower arch was markedly enlarged, the apex was broadened,

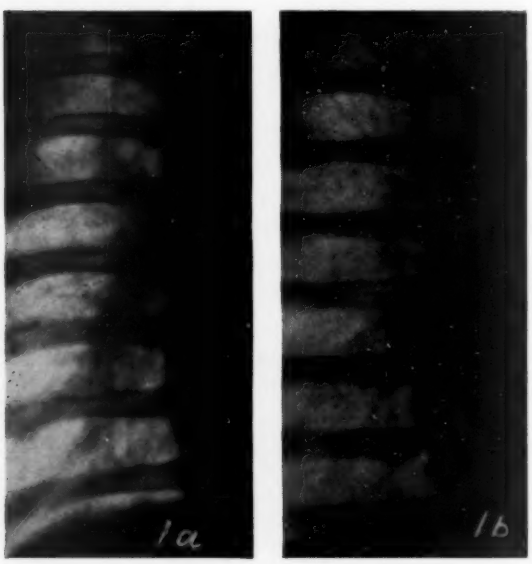


FIG. 1. *a*, hilar "comma" and hilar markings in a normal infant five months of age; *b*, missing hilar comma and narrow hilar markings in a case of truncus aorticus solitarius with pulmonary atresia and heterotopic pulmonary circulation.

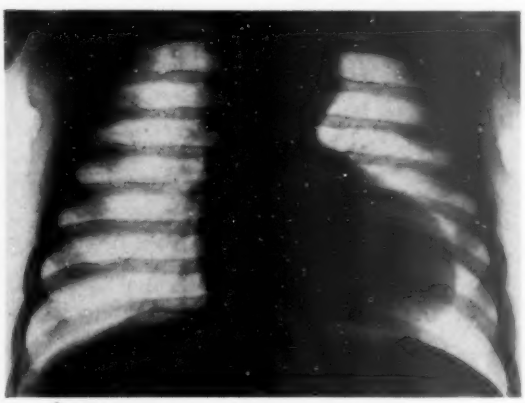


FIG 2. Chest roentgenogram of an infant aged five months. Marked enlargement of the left lower arch. "Coeur en sabot" indicating marked enlargement of the right ventricle. Deep incisure at the heart waist suggestive of a displaced or absent pulmonary conus. Absent hilar comma and narrow hilar markings indicating absence of pulmonary arteries. For autopsy findings see Figures 3 and 4.

rounded and elevated in the fashion of a "coeur en sabot." The appearance of the right heart border was essentially normal. Roentgen diagnosis of a congenital heart lesion was made and the presence of several anomalies suspected.

The autopsy performed by Dr. I. Davidsohn revealed the following findings in the heart and the great vessels (Fig. 3): After opening the pericardial sac, the right ventricle is visible; of the left ventricle only a narrow anterior margin is seen. A large blood vessel is seen anteriorly originating from the right ventricle corresponding to the location of the pulmonary artery. On opening the heart, this vessel is found to override the bases of the right and left

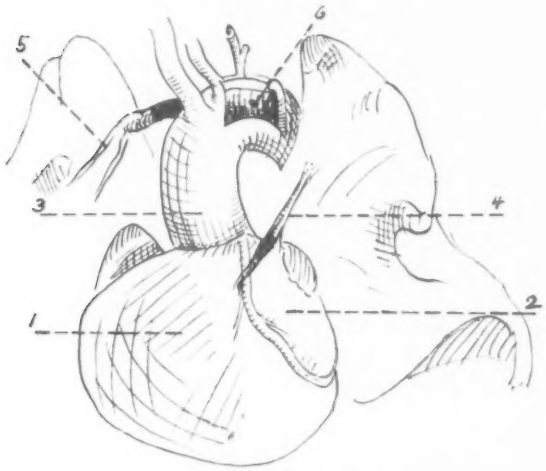


Fig. 3. Same case, findings at autopsy. Right ventricle, *1*, markedly enlarged forming the blunt apex of the heart. Left ventricle, *2*, is small. The solitary arterial trunk, *3*, originates mainly from the large right ventricle but is partly overriding an interventricular septal defect. The pulmonary artery, *4*, is an extremely small vessel ending blindly in the wall of the right ventricle. The pulmonary vessels for the right lung, *5*, branch off the left subclavian artery which springs from the posterior aspect of the aortic arch, *6*.

ventricle. It has the normal number of cusps. Two normal orifices of coronary arteries are found in the normal location. The heart appears enlarged measuring 50 by 55 mm. The left auricle shows no abnormalities. It is small in size. The left ventricle is small. The wall measures 5 mm. in thickness. A small defect is present at the upper end of the interventricular septum about 4 by 3 mm. in size. The right ventricle is large, the wall is hypertrophied and measures 8 mm. The right auricle is dilated and the wall is thin. The foramen ovale is patent. The truncus solitarius is wide, measuring 40 mm. in circumference. The intima shows no abnormalities. The right common carotid artery originates normally from the aorta. It is followed in the normal position by the left common carotid and

Fig. 4. Same specimen, posterior view. The abnormal left subclavian artery, *1*, crosses behind the esophagus and trachea to give off branches to the right lung, *2*. Overdeveloped bronchial vessels originating from the anterior surface of the descending aorta, *3*, supply the left and the lower part of the right lung.

left subclavian artery, while the right subclavian artery originates about 10 mm. below the origin of the left subclavian artery directly from the aorta. It runs behind the esophagus to the right and gives off a branch which supplies the right lung (Fig. 4). A thin blood vessel originates at the base of the right ventricle close to the interventricular septum and runs up to the hilum of the left lung (Fig. 3). It does not communicate with the ventricle, but ends blindly in the wall of the heart with a knob-like structure. Several branches of the aorta, all thin, supply both lungs.

The autopsy report showed that we were dealing with a dextroposed truncus aorticus solitarius, pulmonary atresia, interventricular septal defect, and heterotopic pulmonary blood supply. With the knowledge of these findings we re-examined the roentgenogram and became aware of a roentgenographic sign which, if properly observed and interpreted, would have guided us to a much more detailed diagnosis of this congenital anomaly. This roentgenologic sign is the *almost complete absence of hilar shadows*. A few small vascular markings

were seen, but the typical "hilum comma" was entirely missing (Fig. 1 and 2). In order to give a satisfactory explanation for the absence of the latter, a discussion of the subgroups of solitary arterial trunk and of the accompanying various types of pulmonary blood supply is justified.

If one large solitary vascular trunk emerges from the base of the heart instead of the two trunks of aorta and pulmonary artery, one of four developmental anomalies is possible (Fig. 5):

(1) A complete persistent common trunk with no trace of separation into two vessels.

(2) A "partial" persistent common trunk where one stem for the right and left pulmonary artery originates from the single trunk. This demonstrates that the septal spur for the formation of the two separate large vessels has started to develop.

(3) A truncus aorticus solitarius with atresia of the pulmonary artery.

(4) A truncus pulmonalis solitarius with atresia of the aorta.

The exact description of these types is beyond the scope of this paper and can be found in various publications (Feller[11], Humphreys,[16] Kugel,[17] Roos,[23] Shapiro[25]). Differentiation is not difficult pathologically. Persistent common trunk presents four cusps or two normal and one large fused cusp. Truncus pulmonalis solitarius shows three cusps but no coronary ostia. Truncus aorticus solitarius shows coronary ostia behind two of the three cusps.

A point of importance in connection with the case presented here is the blood supply to the lungs for re-oxygenation in these anomalies. There are five possibilities (Fig. 4 and 5):

(1) A stem giving off a fairly normal right and left pulmonary artery is found on the anterior surface of the solitary trunk.

(2) Right and left pulmonary arteries may emerge separately from the anterior or posterior aspect of the solitary trunk without a common stem. The vessels may be of normal size, enlarged, or hypoplastic.

(3) The distal (aortic) portion of Botallo's duct remains patent supplying two pulmonary arteries. These have no direct connection with the ascending part of the vascular trunk and generally are markedly underdeveloped.

(4) Supernumerary vessels derived from the aorta and usually referred to as overdeveloped or supernumerary bronchial arteries springing from the inner surface of the aortic arch or from the descending aorta maintain a pulmonary blood circulation. These vessels are much narrower than a normal pulmonary artery. Occasionally each vessel supplies only one lobe of the lung. In this way multiple small hila are formed.

(5) A similar pulmonary blood supply may be derived from a subclavian artery, or some combination of the aforementioned pulmonary circulations may occur wherein the right and left side present different sources of vascular supply (Fig. 4).

The various types of pulmonary circulation are described in detail since these have some bearing on the roentgenographic ap-

FIG. 5. Subgroups of *truncus arteriosus solitarius*.

a, ***complete persistent common trunk***. Four cusps, two coronary ostia, right and left pulmonary artery originate separately from the common trunk.

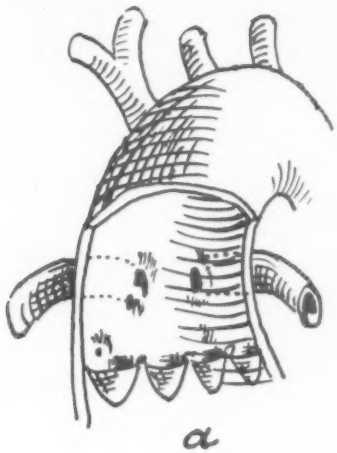
b, ***"partial" persistent common trunk***. Beginning separation into aorta and pulmonary artery. A short common stem springs from the trunk dividing immediately into the two pulmonary arteries.

c, ***truncus pulmonalis solitarius***. Three cusps, no coronary ostia. Right and left pulmonary artery well developed. The widely patent Botallo's duct, *4*, carries the blood to the aortic arch, *5*. The ascending aorta, *1*, is atretic or remains a narrow vessel supplying the coronary arteries, *2* and *3*.

d, ***truncus solitarius aorticus***. Three cusps, two coronary ostia. Pulmonary artery, *4*, atretic. The undeveloped right and left main branches, *2* and *3*, are supplied by the patent distal part of Botallo's duct, *1*. These pulmonary arteries may be undeveloped and other vessels may take over the pulmonary circulation (Fig. 4 and *5f*).

e, pulmonary artery for the right, supernumerary bronchial artery for the left lung.

f, supernumerary bronchial arteries forming the only pathway of pulmonary circulation.



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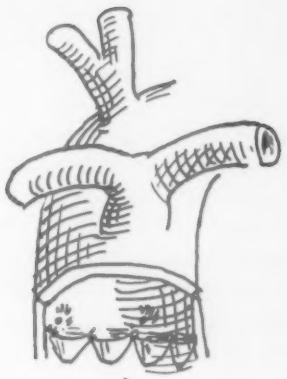

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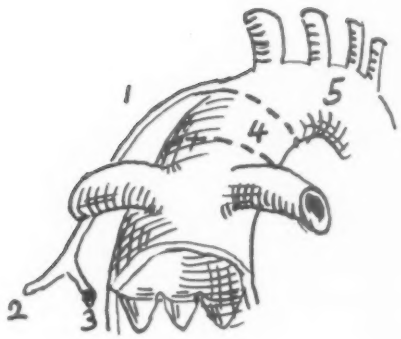

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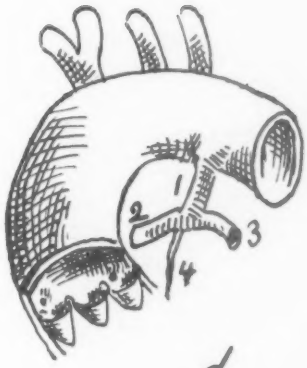

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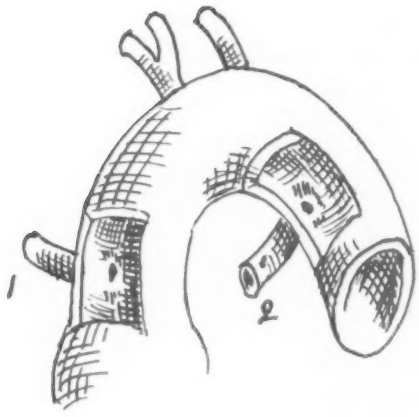

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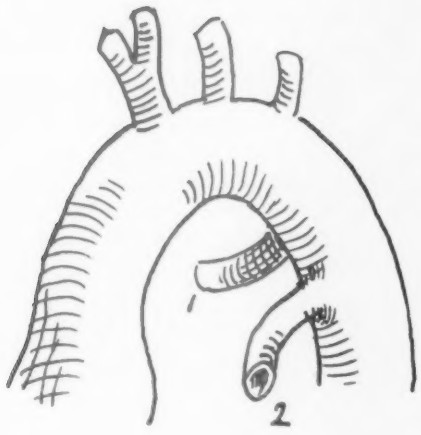

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pearance of the hila. It is generally acknowledged that the "comma" of the hilar shadow is formed almost exclusively by the descending main branch of the pulmonary artery. The normal hilar lymph nodes are roentgenographically invisible and the normal bronchus through its air content cuts off a part of the hilar density, but does not add to its shadow. *Consequently, total absence or marked underdevelopment of the right and left pulmonary artery must result in an appreciable diminution or total disappearance of the normal hilar comma.* It is surprising that this possibility is hardly mentioned in the textbooks or in special publications dealing with the roentgenology of the hila or of cardiac anomalies. The *enlarged* hilum has captured the entire imagination and interest of roentgenologists. Only Assmann[3] reports and illustrates one case of pulmonary stenosis where the hilar shadows appeared narrowed. Unfortunately, in the German literature congenital atresia and congenital stenosis are not clearly differentiated. On reviewing the literature of this subject we found many illustrations on too small a scale or too blurred to permit reliable judgment concerning the hila. Not infrequently only a drawing of the cardiac outline is included since the appearance of the hila was considered unimportant. Giving full consideration to these difficulties I suspect the presence of abnormally small hila in several instances (Assmann,[3] Vol. I, Fig. 95 and 105; Blackford and Hoppe,[5] Fig. 1; Gibson[12] in Brenneman, Vol. III, Chap. 13, Fig. 10; Kugel,[17] Roesler,[22] Fig. 162 and right hilum of Fig. 164).

When analyzing the question of how often in cases of solitary arterial trunk the roentgenographic coincidence of a receding pulmonary arch with the absence of hilar shadows may be found, the difficulty arises that pathologic classification is not uniform. Some authors[23] consider only 6 cases as definitely proved instances of persistent common trunk; others consider solitary pulmonary trunk with aortic atresia as the rarest of the four conditions. Moreover, cases of solitary aortic trunk have been classified under the heading of pulmonary atresia with interventricular septal defect or merely as pulmonary stenosis. Some cases of right-sided solitary aortic trunk may be found in discussions of the tetralogy of Fallot. This is easily understood since the four cardinal signs of the tetralogy—stenosis at the pulmonary ostium, dextroposition of the aorta, hypertrophy of the right ventricle, and interventricular septal defect—are present. From the viewpoint of the roentgenologist it seems preferable to limit the term tetralogy of Fallot to cases where only stenosis but no complete atresia of the pulmonary artery is found so that this vessel participates in the pulmonary circulation. Where complete atresia is present with other vessels maintaining the entire pulmonary blood supply, classification as solitary aortic trunk seems preferable. This differentiation is desirable since in pulmonary stenosis the concentrated narrowed blood stream may produce a *widening of the pulmonary artery* distal to the stenosis where it meets the wall of the vessel. Therefore a certain percentage of pulmonary stenoses and tetralogies of Fallot present roentgenographically *enlarged* pulmonary arch and vessels. This will not be seen in truncus aorticus solitarius with atresia of the pulmonary artery.

For further analysis, we have to consider all the types of solitary arterial trunk as a whole. Statistics on the pathology showing how often a fairly normal right and left pulmonary artery were found, how often the vessels were underdeveloped, and how frequently abnormal pulmonary blood supply was demonstrated, are not available. Reviewing 27 cases of solitary arterial trunk where information of the pulmonary circulation was given, I found in 10 cases fairly normal right and left pulmonary arteries, in 5 cases narrowed pulmonary arteries and in 13 cases heterotopic pulmonary blood supply from supernumerary bronchial arteries or other vessels coming from a subclavian artery, the arch or the descending portion of the aorta. This gives

a percentage of 64.3 of possible diminution or absence of the hilar comma. Of this number an unknown deduction has to be made for such cases where the total enlargement of the heart covers the hilar region. It seems worth while to mention that of the 13 patients with non-functioning pulmonary arteries and heterotopic blood supply, several have reached adulthood.[9,15,22,28]

The observation of a depression or absence of the second left arch as a sign of a displaced, narrowed or absent pulmonary conus was previously described by Assmann,[3] Fanconi,[10] Taussig,[27] and others, and is clearly visible in our case. Besides the tetralogy of Fallot, this observation was made in transposition of the great vessels wherein aorta and pulmonary artery are lying behind each other instead of side by side. The peculiar combination of the receding second left arch giving a particularly clear visualization of the hilar region with the absence of the hilar comma could exist only in complete pulmonary atresia with heterotopic blood supply, i.e. in solitary aortic trunk.

In truncus pulmonalis solitarius and in partial persistent common trunk, the development of two normal sized pulmonary arteries appears to be the rule. These conditions, therefore, may be excluded. The roentgenologic differential diagnosis in our case therefore should be: (1) truncus arteriosus solitarius with heterotopic pulmonary blood supply and (2) the rare incidence of complete persistent truncus arteriosus communis with heterotopic pulmonary blood supply.

SUMMARY

(1) The absence of the hilar shadow is described as a new roentgenographic sign in the diagnosis of rare cardiac anomalies.

(2) The absence of the hilar shadow is explained through the absence or the marked underdevelopment of the right and left pulmonary artery. The pulmonary circulation in these cases is maintained through the patent distal part of Botallo's duct, through supernumerary bronchial arteries or through a branch of a subclavian artery.

(3) A case of right-sided truncus aorticus solitarius with heterotopic pulmonary blood supply is analyzed anatomically and roentgenographically. Under favorable conditions, exact roentgen diagnosis should be made.

(4) The roentgen diagnosis of this condition can be made when absence of the hilar shadows is associated with a deep depression at the site of the pulmonary conus.

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SYPHILIS OF THE LUNG*

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SYPHILIS by definition is a systemic infection of the body caused by a specific organism, the *Treponema pallidum*. At its very onset the infection becomes generalized and so protean in its manifestations as to be able to simulate almost any disease process in the body. Numerous indeed are the lists of differential diagnoses which take syphilis into account.

Acquired syphilis of the adult lung, up until a fairly recent period, was considered exceedingly rare and many clinicians doubted the possibility of its existence. There are still those who will not make such a diagnosis, but enough cases have been reported in late years, upon a sufficiently reasonable basis, as to seem to establish it as a definite entity. Therefore, to assume that such a pathological process cannot occur does not appear logical. In attempting to determine the cause of any obscure pulmonary lesion one must consider syphilis in the differential diagnosis.

In the literature, figures regarding the incidence of adult pulmonary lues vary widely. Osler[5] mentions that only 4 cases were found in a series of 2,806 autopsies at Johns Hopkins Hospital. Carrera[2] in a pathological study of the lungs, in 152 autopsy cases of syphilis, found 12 with pulmonary lesions. Krause[4] recorded only 5 cases among 20,000 admissions to the Munster Clinic. Claytor[3] reported no cases in 13,000 specimens at the Army Medical Museum.

From the pathological aspect the lesions found in the lungs, in adult pulmonary syphilis, have been described as of several types, and one or more of them may be found in the lungs at the same time. According to Piersol[7] there are three main types found. The first of these includes gummata. He states they are more common in the lower lobes or about the hila, are apt to be multiple and vary in size from a millet seed to a hen's egg. They are at first grayish-red in color, translucent and surrounded by areas of congestion, later becoming more opaque and sometimes slightly caseous. Most gummata, according to this author, become healed, leaving dense areas of scar tissue at the site of former lesions. The second type of changes he describes is that of areas of consolidation and catarrhal inflammation usually occurring about the roots of the lung or at the hilum. Finally, chronic fibrosis may be found resulting from an inflammatory change, consisting of extensive cellular infiltration with an overgrowth of connective tissue in the interlobular septa which becomes converted into an area of fibrotic tissue resembling that from any other cause.

As far as symptoms and signs are concerned, there is nothing characteristic about adult pulmonary syphilis. It may resemble, clinically, tuberculosis, bronchiectasis, cancer or cardiac disease and should be considered in the diagnosis of any obscure chest condition. Undoubtedly, cases must occur in which the patient is unaware of a lung condition, just as in other diseases.

The determination of acquired pulmonary syphilis in a living person may be difficult and made only after exclusion of other more common chronic lung disorders. The following points will aid in arriving at such a diagnosis:

(1) History of insidious onset, in a middle-aged person, of a chronic progressive lung disturbance, the gravity of which clinically would seem to be mild and out of proportion to the severity of the pulmonary

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FIG. 1. Roentgenogram dated December 29, 1930, taken on first admission, showing deformity of the prepyloric region, suggesting cancer.

lesion as determined by physical and roentgenographic examination.

(2) A history of venereal infection with onset of the pulmonary disturbance occurring at a time when tertiary luetic lesions might be expected in the course of the disease.

(3) Positive blood serology and also the possible presence of other syphilitic lesions in the body.

(4) Consistently negative sputum for tubercle bacilli and fungi.

(5) Exclusion of newgrowths and bronchiectasis by lipiodol and bronchoscopic examinations.

(6) Therapeutic response to antisyphilitic drugs as determined by serial roentgenograms. This is not entirely conclusive as the lesion occasionally may not improve or disappear.

(7) The finding of the spirochete in the sputum smear which would be a conclusive finding, but unfortunately this has been successful in only a very few instances.

Pearson[6] reviewed the literature and reported the most common roentgenological manifestations of adult pulmonary syphilis. These are summarized briefly as follows:

1. Infiltration, lobar or patchy in distribution and involving one or more lobes.

2. Opacities, oval in shape, single or multiple, most often in the lower lobes, often not connected with the hilum and measuring in diameter from a few millimeters to several centimeters.

3. Generalized accentuation of the bronchial and vascular shadows, extending from the hilar regions to the periphery.

4. Opacity of one lobe or a whole of one side of the chest with displacement of the mediastinum towards the side of the lesion, denoting fibrosis or atelectasis which may be accompanied by pleural effusion.

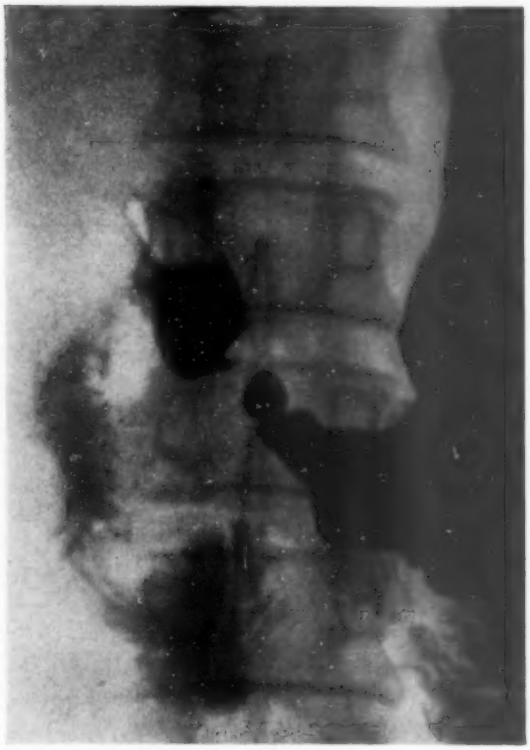

FIG. 2. Roengenogram taken on May 20, 1931, during patient's first admission, revealing the improved appearance of the pyloric end of the stomach following antiluetic treatment.

This same author also states that many cases may demonstrate not only one of the above lesions but may represent a composite picture of two or more of these groups.

CASE REPORTS

Patient, C. McD., was previously reported as a case of gastric syphilis in 1935 by Biscoe.[1] It was one of eight in a series of cases of syphilis of the stomach he reported which had been diagnosed on the basis of roentgen examinations, serologic tests and response to antiluetic therapy. This World War I veteran, aged thirty-seven, was first admitted to Hines Hospital, December 24, 1930, complaining of epigastric pains coming on about an hour after meals and gradually clearing up before the next meal. He dated the onset of symptoms as about January, 1929. For about six months prior to admission, these pains became more severe and constant and were often accompanied by vomiting with no relief. He had lost

Fig. 3. Roentgenogram on April 26, 1940, depicting the appearance of the stomach which still exhibits evidence of prepyloric narrowing and a filling defect, but much less marked than at the first examination.

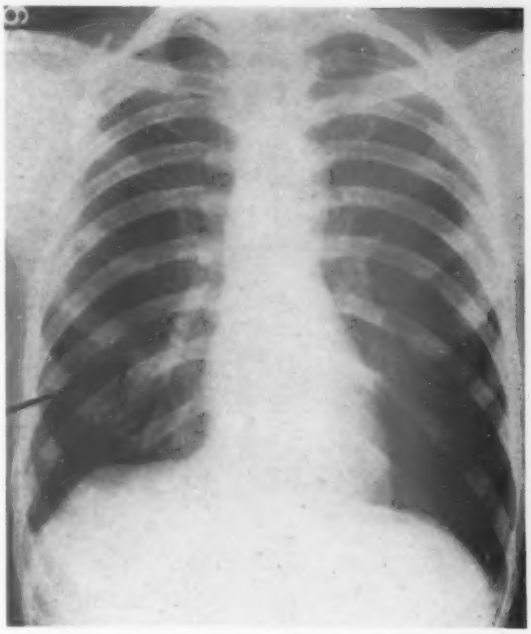

Fig. 4. Chest roentgenogram dated December 24, 1930, taken on first admission, demonstrating lesion in right lower lung (see arrow).

51 pounds in weight since the onset of his symptoms. His appetite and strength had gradually diminished. His family history and past history by systems have no important relationship to his present illness or physical findings. He denied the use of drugs, alcohol or tobacco. Venereal exposure was denied.

General physical examination revealed the man to be markedly emaciated but failed to disclose any other positive findings. Blood counts and urine examinations revealed no abnormal findings. The blood Wassermann test was 100 per cent positive and the Kahn test was 4 plus. The spinal fluid examination revealed a negative Wassermann reaction and normal colloidal gold curve. Fractional test meal studies of the stomach contents showed free acid in the first two specimens, combined acid in all the specimens and occult blood in the last specimen.

The gastrointestinal tract, by repeated barium meal roentgen studies, displayed a prepyloric filling defect, suggestive of cancer (Fig. 1). There was also evidence of partial pyloric obstruction.

The chest roentgenogram showed an irregular area of increased density around the lower bronchopulmonary markings near the hilum, the significance of which was not evident at the

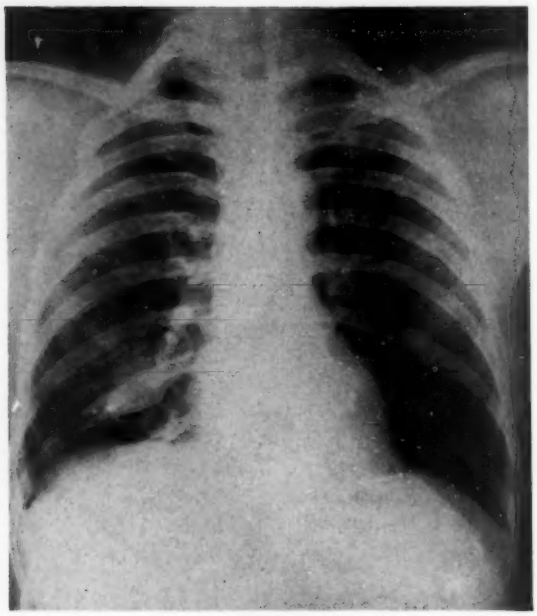

FIG. 5. Chest roentgenogram dated November 18, 1937, showing the lesion in right lower lung field to be more dense than on previous examinations.

time (Fig. 4). There had never been a history of pulmonary symptoms and repeated sputum smears failed to disclose tubercle bacilli. The patient had no other findings suggestive of pulmonary tuberculosis. During his stay in the hospital he underwent antiluetic treatment. There followed marked improvement in symptoms and a gain in weight of 53 pounds. There appeared to be improvement in the stomach defect, as determined by repeated gastrointestinal roentgen studies (Fig. 2). The blood Wassermann reaction became negative by the time of discharge on March 31, 1932. On the basis of positive serological findings, roentgen studies and improvement following antiluetic treatment, a diagnosis of gastric syphilis was made. The lung lesion noted in the chest roentgenogram was not definitely diagnosed at that time.

The patient was readmitted for periods of observation and treatment from July 25, 1932, to March 1, 1933, from October 27, 1933, to April 26, 1934, from November 15, 1934, to February 21, 1935, from December 15, 1936, to January 22, 1937, from August 17, 1937, to November 29, 1937, and from April 22, 1940, to May 14, 1940. He was subjected to repeated gastrointestinal and chest roentgen studies during these episodes of hospitalization and underwent intensive antiluetic treatment during each period, with the exception of the last. Following each admission, exclusive of the last, the blood Wassermann reaction was positive to variable degrees and became negative following specific therapy. Symptoms referable to the gastrointestinal tract were minimal at each admission. He never complained of any pulmonary condition. The gastric lesion was displayed in all roentgen studies but appeared to have improved at each period of observation. The last study still showed evidence of a prepyloric narrowing and filling defect but much less marked than at the first examination (Fig. 3). The patient continued to feel in very good physical condition following his first period of hospitalization.

The lesion in the right lower lung field was still evident on subsequent roentgenographic examinations of the chest and appeared denser and more sharply circumscribed than on previous films (Fig. 5 and 6). Physical findings in the chest were essentially negative on all admissions and nothing was ever found to indicate that the lung lesion could be explained upon any other etiological factor but that of syphilis. Upon the basis of positive serological findings, the presence of another visceral luetic process and the appearance and location of the lung density on the roentgenograms, it was decided that this was a case of a pulmonary syphilitic lesion.

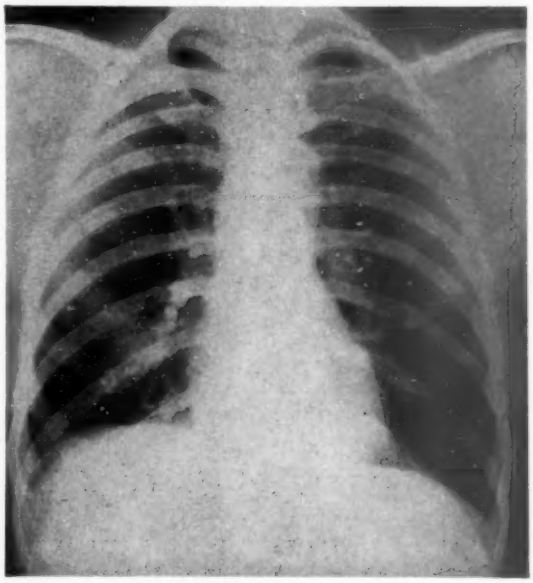

FIG. 6. Roentgenogram dated April 24, 1940, showing the pulmonary lesion on last admission which appears about the same as in 1937.

Comment. It is admitted that such a diagnosis in this case is highly circumstantial but it seems logical in the light of the other positive findings. In our estimation, this is an example of a chronic fibrotic lesion, as described above by Piersol, resulting from an inflammatory change due to syphilis. This would explain its failure to disappear following specific therapy.

So far as we have been able to determine from the records of this institution, this is the first time that the diagnosis of two such uncommon visceral lesions of syphilis has ever been made in the same individual.

We are indebted to Ralph C. Creer for his aid in photographing the illustrations accompanying this article.

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HYPERPARATHYROIDISM*

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A REVIEW of the literature reveals that Askanazy,[4] in 1904, was the first to suspect a relationship between the parathyroid glands and decalcification of the skeleton. MacCallum[19] in 1905, drew attention to the relationship between a tumor of the parathyroid gland and chronic renal disease in which the renal disease overshadowed the skeletal changes. Erdheim[11] in 1907, commented on the frequency of hypertrophy of the parathyroid glands in cases of osteomalacia. Schlagenhaufer,[22] in 1915, discussing 2 cases of this disease in which an enlargement of the parathyroids was found at autopsy, raised the point that this condition might be due to these tumors. This was in direct contradiction to the prevailing view that the enlargement of these glands was a secondary effect. The honor of conclusively establishing the relation between adenomas of the parathyroid and bone decalcification belongs to Felix Mandl[18] who, in 1925, by removing surgically an adenoma of the parathyroid, alleviated the metabolic dysfunction in a case of hyperparathyroidism. Wilder and Howell[28] in 1936, reviewed 135 proved cases of hyperparathyroidism, basing their criteria for acceptance on (1) that the report of the case has appeared in the literature, (2) that the description of the skeletal abnormalities present be consistent with that of generalized osteitis fibrosa or, in the absence of skeletal abnormality, that indisputable abnormality or calcium metabolism, characteristic of hyperparathyroidism, has been demonstrated by the study of the blood or urine, and (3) that a tumorous enlargement, either adenoma of one or more parathyroid glands or diffuse hypertrophy and hyperplasia of the entire parathyroid apparatus, has been found either by operation or by necropsy. Additional cases are constantly appearing in the literature.[3,15,25,26]

The signs and symptoms of hyperparathyroidism have been well summarized by Shelling:[23]

1. General
   a) Weakness
   b) Loss of appetite
   c) Loss of weight
   d) Muscle and joint pains
   e) Constipation and abdominal pain
   f) Bradycardia and cardiac irregularities
   g) Polydipsia
   h) Hypochromic anemia
2. Skeletal
   a) Generalized decalcification
   b) Cysts and giant cell tumors
   c) Fractures
   d) Lumps
   e) Skeletal deformities and shortenings
   f) Epulides
3. Urinary
   a) Polyuria
   b) Albuminuria
   c) Dysuria
   d) Hematuria
   e) Milky urine or gravel
   f) Renal, ureteral or vesical calculi
   g) Renal colic
   h) Diminished renal function
   i) Nephrocalcinosis
4. Metastatic
   a) Arterial calcification
   b) Broncholithiasis and pulmonary calcinosis
   c) Generalized calcinosis
5. Metabolic and Chemical
   a) Hypercalcemia
   b) Hypophosphatemia
   c) Hypercalciuria
   d) Hyperphosphaturia
   e) Increase in serum or plasma phosphates

The symptoms in any individual case may vary widely, depending upon whether

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the skeletal changes of osteitis fibrosa cystica, generalized decalcification of the skeleton without cysts or giant cell tumors, or deposition of calcium in the soft tissues, most notably in the kidneys, predominates. Gutman, Swenson and Parsons[13] list the following early and late symptoms in a review of 115 cases of hyperparathyroidism:

Symptoms	Major Initial Symptoms Per Cent of Cases	Major Late Symptoms Per Cent of Cases
Skeletal		
1. Pain in back or extremities	72	62
2. Muscle weakness	22	23
3. Pathological fractures	28	40
4. Bone swelling	26	22
5. Gross deformities	19	30
6. Disturbance of gait	24	22
7. Bedfast	4	31
Renal		
1. Polyuria, polydipsia	10	11
2. Colic	9	3
Gastrointestinal		
1. Nausea and vomiting	8	12
2. Anorexia	3	9
3. Epigastric pain	2	5
Miscellaneous		
1. Marked loss of weight	10	24

Shelling[24] found the RT interval markedly shortened in hyperparathyroidism. The duration of RT in the normal electrocardiogram is 0.26 to 0.28 second. In our case the RT interval was 0.20 second. If the RT interval were routinely measured by those interpreting electrocardiograms, it seems likely that more cases of this disease would be discovered. Little attention has been given this diagnostic aid heretofore.

Most cases of hyperparathyroidism occur in middle adult life, in females more commonly than in males. Landon[17] reported a case in which cysts of the jaw and calvarium were already present at the age of six months. The course may be acute and fulminating or chronic. In one of Albright, Aub and Bauer's[1] patients, there is reason to believe symptoms of hyperparathyroidism had existed for thirty-nine years.

Hypercalcemia is an important finding in cases of suspected hyperparathyroidism, especially if accompanied by other signs and symptoms of overactivity of the parathyroid bodies. It is not, however, pathognomonic, as the level of serum calcium may be increased in cases of multiple myeloma,[8,9] metastatic carcinomatosis[6] and polycythemia vera. On the other hand, normal values for serum calcium have been reported in proved cases of hyperparathyroidism. Detailed calcium and phosphorus balance studies may be carried out in doubtful cases. Nausea and vomiting are not generally believed to be due to the hypercalcemia *per se*. However, in our case, we noted the severity of vomiting varied in direct proportion to the level of serum calcium. Reed[21] reported a young adult who maintained hypercalcemia of 24 mg. for eight days by vitamin D overdosage without evidence of toxicity or subsequent damage.

In health about 90 per cent of calcium excreted is found in the feces, only small amounts being present in the urine. In hyperparathyroidism the reverse holds true unless large amounts of calcium are ingested. A high urinary output of calcium is a very significant finding. Normal individuals receiving 0.1 gram of calcium daily were found by Aub, *et al.*[5] to excrete only 0.19 gram of calcium in the urine in a three day period.

The etiology of hyperparathyroidism remains unknown. Wilder and Howell[28] postulate the presence of cells which preserve an embryonic capacity for proliferation in certain individuals. We have thus the potentiality for adenoma formation. Whether or not a parathyroid adenoma develops depends upon the intensity of stimulation to which these cells are subjected by insufficient vitamin D. In support of their contention, they cite the relatively high incidence of hyperparathyroidism in England and the New England states where

vitamin D deficiency is favored, due to fog, smoke, haze and indoor living habits. In our case presented here vitamin concentrates given in large doses gave no apparent beneficial results.

Much speculation and numerous theories have been advanced to explain the mechanism by which the bones become demineralized. Greenwald and Gross[12] suggest the parathyroid hormone causes the production of a soluble but unionizable compound of calcium so that the equilibrium is shifted from bone to blood with a resultant decalcification. No such a compound of calcium has ever been found to exist in cases of hyperparathyroidism. Albright and Ellsworth[2] and Ellsworth[10] advanced the view that parathyroid hormone lowers the renal threshold for excretion of phosphate, leading to subsaturation of calcium phosphate in the serum with a compensatory removal of calcium from the bones, since about 90 per cent of bone is composed of tricalcium phosphate. However, the mechanism of decalcification remains unexplained and no explanation can be given to account for the demineralization in those cases of hyperparathyroidism with hyperphosphatemia. Thomson and Collip[27] hold that the action of parathyroid hormone is that it directly stimulates the osteoclast to erode bone and liberate calcium. However, decalcification has been noted by Jaffe[16] to occur before the appearance of osteoclasts. He states that there is "reason to believe that in hyperparathyroidism the tissue fluids circulating about the bone are so changed and modified as to favor removal of minerals from the bone rather than their disposition." No explanation of the mechanism involved is presented.

It appears the best explanation offered is that of Shelling[24] who reasons that the parathyroid hormone increases the solubility of calcium phosphate in the blood, hence there is a shift in equilibrium between the solid phase, the bones, in favor of the liquid phase, the blood. He lists the physiochemical factors governing calcium phosphate solubility in serum or urine as (1) the pH; (2) protein concentration in the serum; (3) presence of substances capable of forming soluble but poorly dissociable compounds with calcium or with phosphate; (4) magnesium concentration, and (5) the total ionic strength of the solution. He believes that the pH of the blood varies little, serum protein concentration is not altered greatly, that substances similar to calcium citrate have not been detected, and therefore changes in the magnesium concentration and total ionic strength are chiefly involved. Of these the changes in total ionic strength are considered most important. Parathyroid hormone is known to produce diuresis before greatly increasing the output of urinary calcium. Sodium chloride is excreted in excessive amounts, the electrolytic balance is upset and new equilibria are thus formed between the intracellular spaces, the blood and skeletal system. With the increase in water, magnesium, sodium and chloride in the fluid circulating about the bones, the calcium phosphate equilibrium is shifted in the direction of the blood, with a resultant demineralization. A part of the resorbed matrix is phagocytosed by osteoclasts, a part heals by fibrous replacement and a small portion maintains the process of new bone formation.

Shelling explains metastatic calcification, resultant from overdosage of parathyroid hormone, on the same basis. Decreased solubility of calcium phosphate results from loss of electrolytes and water, and precipitation occurs in tissues which normally present marked variations in pH, e.g. kidneys, lungs and stomach.

Since hyperparathyroidism is definitely known to be associated with hypertrophy or hyperplasia of one or more parathyroid bodies, the treatment of choice is parathyroidectomy. Excellent results are obtained following this procedure. The principal difficulty encountered is to locate these elusive bodies. Embryologically, they are derived from the third and fourth lateral anlagen and occasionally from the fifth branchial pouch. It can thus be seen that

they may be encountered anywhere from the pharynx to the mediastinum. If not found at the first operation, resulting scar tissue makes the undertaking more difficult. Not infrequently such marked cachexia exists as to preclude the possibility of surgical intervention. Jacox, King and Bailey[14,15] have ably reviewed the literature on the effect of irradiation. The recorded results compare favorably with surgery. Their use of selective irradiation as an aid in localizing parathyroid lesions before surgery merits wider application. Dietary management has little to offer and results have been uniformly disappointing.

CASE REPORT

This patient was discharged from the Army January 12, 1940, apparently in good health. He arrived at his home in Wichita from the Hawaiian Islands on January 16. The following evening he developed what appeared to be a severe cold with symptoms of coryza, cough, nausea and vomiting. He never did recover completely. About three weeks later he noted rather dull, constant pain in the right anterior chest, right arm, both hips and legs. Nausea and vomiting became worse and loss of weight evident. He became progressively weaker, and on February 15 collapsed on his way to the bathroom. By the end of February he was completely bedfast, having lost about 50 pounds. He was hospitalized one week at a Wichita

Fig. 1. Roentgenogram of pelvis, showing osteoporosis, and thinning of compact bone.

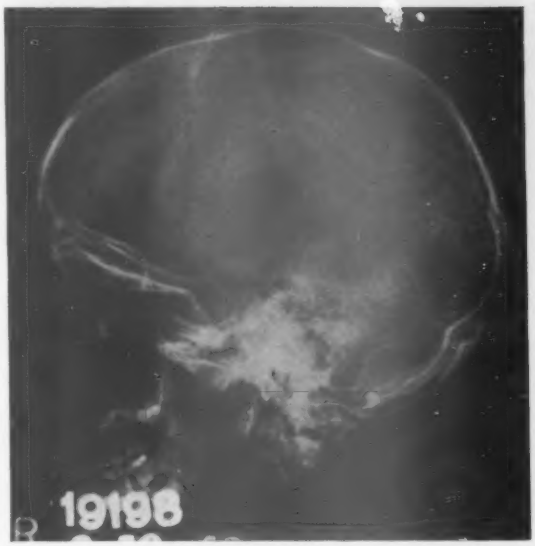

Fig. 2. Skull. Stippling and granular appearance. Note fuzziness of outline of outer table.

hospital for observation and treatment and was discharged unimproved. On April 1 he re-entered the hospital. Here roentgenograms showed a marked generalized bone decalcification. Blood calcium was found to be 18 and 19 mg. per 100 cc. A tumor of the parathyroid glands was suspected. On May 20 an exploratory operation was done. His surgeon, Dr. James S. Hibbard, reported: "The entire thyroid region was explored anteriorly, laterally and posteriorly, as well as the tracheal and esophageal regions. In the region of the inferior thyroid artery a parathyroid body the size of a small pea was found, and a quick section by Dr. Jager revealed a marked hyperplasia. Two other bodies which were definitely enlarged were also resected, leaving him the right superior which could be identified. No adenomas were found. I explored posteriorly to the sternum as far as I could reach, but felt it advisable to delay a more drastic exploration of his mediastinum, due to his poor condition."

Postoperatively, he responded well; he stopped vomiting and gained about 20 pounds. He left the hospital June 7 on wheelchair status, returning to his own home where he gradually grew worse. He was admitted to the Veterans Administration Facility, Wichita, on June 17, 1940. Examination revealed a tall, emaciated, cachectic, anemic, bedfast white male, aged twenty, who appeared older. Blood calcium was 18.2 mg. per 100 cc.; 6.3 grams of calcium were

FIG. 3. Hands and wrists. Note the decalcification along the epiphyseal lines in radius, metacarpals and phalanges.

excreted in a twenty-four hour urine. Roentgenograms of the bones showed a marked generalized decalcification. The fourth lumbar vertebra was considerably narrowed, which would appear to account for his complaint of pain in this region. Other laboratory tests were not pertinent except the following: erythrocyte count, 2,100,000; hemoglobin 52 per cent (Sahli); leukocyte count, 7,800; with polymorphonuclears 48 per cent, lymphocytes, 48 per cent, monocytes, 4 per cent; the electrocardiogram showed an RT interval of 0.20 second.

On July 2, 1940, he was transferred to the Facility at Hines, where deep roentgen therapy was considered inadvisable, due to his poor condition. Diagnosis of hyperparathyroidism was concurred in by the Tumor Board. The course of the patient was steadily downhill. He died August 15, 1940. Autopsy revealed no evidence of adenoma.

FIG. 4. Foot and ankle. Note the decalcification along the epiphyseal lines.

A careful search was made of the neck region both in the region of the thyroid and behind and between the trachea and esophagus and behind the sternum for possible enlarged parathyroid bodies. One was found embedded in the right lobe of thyroid which measured 0.3×0.5×1.0 cm. There was very little thyroid tissue remaining; only a small portion was found of the right lateral lobe.

The combined weight of the two kidneys was 400 grams. The capsule stripped easily, leaving a smooth shining surface. On splitting the kidneys there was found to be a large amount of

FIG. 5. Knee. Note the decalcification at epiphysis of femur and fibula.

fine gravel in all of the major and minor calyces and in the pelvis. The ureters were grossly negative. The bladder was negative except that the urine contained a large amount of fine sand, white in color, and obviously calcium.

Cut section of rib showed the cortex extremely thin, not over 1 mm. in thickness. The marrow was pale, almost gray in color and was rather scanty. The ribs cut easily with a sharp knife. The vertebral bodies in the lumbar region were extremely soft and the cortex was very thin, the marrow pinkish-gray in color. A section of the

right femur was removed at the knee, the cortex was also extremely thin, measuring not over 1 mm. in thickness at its heaviest point. No cysts or evidence of new growth was encountered. The pathological diagnoses were: (1) hyperparathyroidism, severe; (2) anemia, secondary, severe; (3) decalcification of skeletal system, severe, secondary to (1); (4) fracture compression, fourth lumbar vertebra, secondary to (3); (5) calculi (gravel) multiple, both kidneys and urinary bladder, secondary to (1).

Microscopic study revealed the following: Lung tissue showed a mild edema but was otherwise negative. The liver showed a slight chronic passive congestion. The heart, thyroid and spleen were essentially negative. The kidneys showed a slight cloudy swelling of the cells lining the connecting tubules and a very mild congestion. Microsection of the pancreas showed nothing unusual. Microsection of the parathyroid showed a diffuse hyperplasia (Fig. 7). The tissue is quite vascular. Small groups of acidophil cells can be seen among the more abundant principal cells. There appears to be a slight increase in the reticulum. Microsection of the bone cortex, decalcified by the method of McNamara, and also the bone marrow, showed the marrow to be relatively acellular and containing a moderate amount of fibrous tissue. A careful search of many slides showed no osteoclasts or "giant cells."

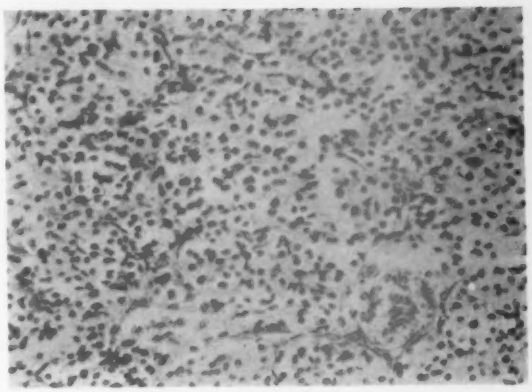

FIG. 7. Photomicrograph of parathyroid. ×800. Note the principal and acidophil cells, and the increased vascularity (diffuse hyperplasia).

FIG. 6. Knee. Decalcification along the femoral and tibial epiphyses with cystic changes along medial margin of tibial diaphysis.

Roentgen study revealed a marked halisteresis of the entire skeleton. All of the bones, and particularly the pelvis, required much less penetration than would normally have been expected. The most striking feature from a roentgen standpoint is the decalcification along the epiphyseal lines, demonstrating the tendency for absorption to occur in localities where bone is laid down last.[20] This is most noticeable in the heads of the fibulae and in the distal epiphyses of the femur and the proximal epiphyses of the tibia, but can also be seen along the epiphyseal lines of the metatarsals, the metacarpals, the radius and ulna, and the distal ends of the tibia and the fibula.

Roentgenograms of the skull were not especially characteristic, showing only a slightly granular appearance. The only evidence of any cystic degeneration appeared at the upper end of the right tibia.

CONCLUSION

A case of hyperparathyroidism is presented with a résumé of the literature. The pathological studies tend to confirm the conclusions of Jaffe, that decalcification occurs before and independent of the appearance of osteoclasts. Additional evidence is presented in support of the theory of Shelling that the RT interval is shortened

in hyperparathyroidism. The case presented illustrates that after removal of one affected parathyroid gland others may hypertrophy and carry on the dysfunction.

The case presented is unusual in several respects. It occurred in an individual only twenty years old. Its onset was acute and the course fulminating, terminating fatally. No adenoma of the parathyroids was found. The roentgenograms showed osteoporosis and absorption of compact bone, with decalcification along the epiphyseal lines almost without cystic degeneration.

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EXPERIMENTAL PRODUCTION OF CONGENITAL SKELETAL ABNORMALITIES IN THE OFFSPRING OF RATS FED A DEFICIENT DIET*

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SINCE congenital malformations play an important part in the pathogenesis of disease of children, their early recognition is desirable from a diagnostic and therapeutic point of view. New diagnostic methods, especially roentgenography, have made it possible to recognize *intra vitam* many congenital defects which previously were discovered only at autopsy. Such advances in diagnosis have made possible a better treatment of congenital defects; and yet it remains the ideal of medicine to prevent such defects rather than to treat them. For this reason the question of the etiology of congenital defects has interested the physicians of all times. At present it seems that congenital malformations can be the result of many causes, in fact the result of any factor which interferes with normal intrauterine development without lethal effect on the embryo. Time does not permit me to enumerate and to discuss here all the teratogenic factors possible, or to go into details of experimental work already done in this field. I shall restrict myself to the report of certain experiments which seem to show that a deficient diet of the mother can result in congenital defects of the offspring.

When female rats are reared and bred on a diet consisting of yellow corn meal 76, wheat gluten 20, calcium carbonate C.P. 3, and sodium chloride C.P. 1 per cent (Steenbock and Black's rachitogenic diet) supplemented by 60 I.U. of vitamin D every tenth day, about one-third of the offspring show congenital malformations. The diet just described will be referred to as diet 1 subsequently. In the accompanying table the breeding results with females reared and bred on this diet are tabulated and compared with the results obtained with females of the same strain bred on an adequate stock diet. In these two groups significantly different results were obtained; it may be added that the one abnormal animal born of a mother on the stock diet showed defects different from those observed on diet 1.

TABLE I

	Total	Normal	Offspring Abnormal	Percentage Abnormal
Diet 1	439	284	155	35.31
Stock diet	544	543	1	0.18

The abnormal offspring obtained on diet 1 can be recognized frequently by external inspection. Shortness of the mandible and protrusion of the tongue are striking ab-

TABLE II

FREQUENCY OF OSSEOUS DEFECTS IN 100 CLEARED ABNORMAL SPECIMENS

Tibia	93	Ulna	50
Mandible	80	Humerus	34
Ribs	75	Hindfoot	31
Fibula	63	Maxilla	8
Radius	58	Scapula	6
Hand	54	Clavicle	6
Sternum	52	Femur	1

normal features. Shortness of the extremities combined with various types of malformations can also be recognized externally. Different degrees of syndactylism of the fingers and toes are frequently observed. However, these external signs do not give a complete picture of the skeletal abnormalities. In attempts to visualize the skeleton by roentgenograms many difficulties were encountered. We turned therefore to a method devised by Schultze and Daw-

* From the Children's Hospital Research Foundation and the Department of Pediatrics, University of Cincinnati, College of Medicine, Cincinnati. Read at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

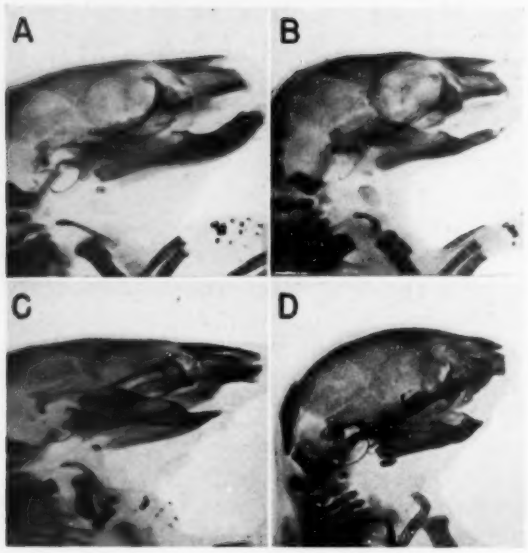

Fig. 1. *A*, head of normal cleared newborn rat. *B-D*, heads of abnormal cleared newborn rats showing increasing degrees of shortening of the mandible.

son by which the soft tissues are made transparent, while the bones, stained by alizarin red S, stand out clearly in the transilluminated specimen. The pictures of the skeleton obtained in this way resemble roentgenograms to a certain extent and remind one of roentgenograms sometimes seen in medical practice.

The different frequency with which various bones were affected in the abnormal animals is indicated in Table II. We cannot explain at the present time why certain bones are so often found abnormal while others are never affected.

The following illustrations demonstrate the different osseous changes as seen in the cleared specimens.

In the normal newborn rat the mandible protrudes in front of the premaxilla (Fig. 1*A*). It consists of a proximal ramus and a distal corpus, both being approximately of equal length. Two incisor teeth are visible in the mandible of the normal cleared specimen. The mandible is found shortened in 80 per cent of the abnormal specimens. Figures 1*B-D* show different degrees of shortening of the mandible. This shortening is due almost entirely to a reduction of the distal part, the corpus, while the ramus appears of normal length. In the more severely deformed specimens the teeth are absent and the corpus is barely visible; the premaxilla may also be reduced in such specimens.

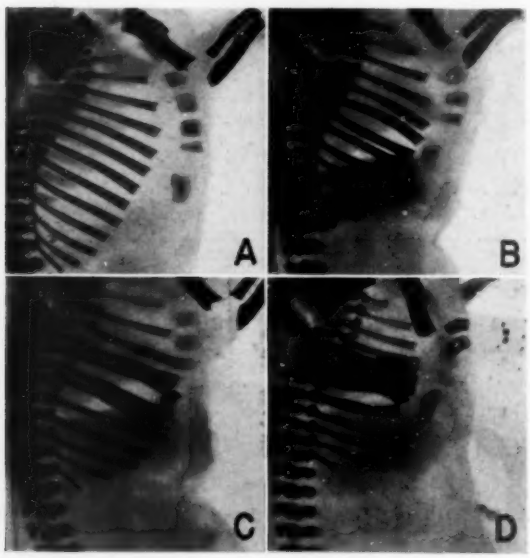

Fig. 2. *A*, side view of chest of normal cleared newborn rat. *B-D*, chests of abnormal cleared newborn rats showing reduction of intercostal spaces and fusion of ribs.

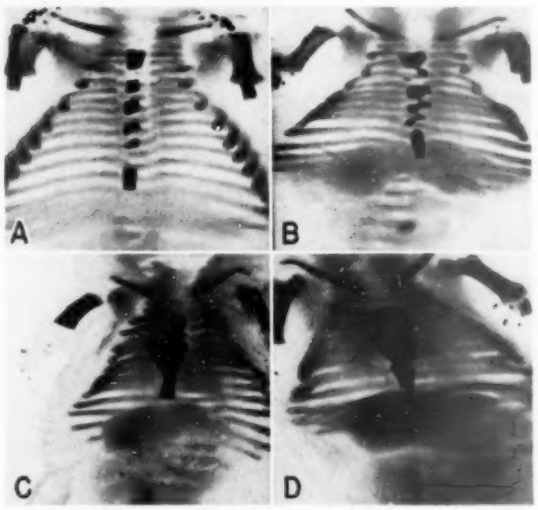

Fig. 3. *A*, front view of chest of normal cleared newborn rat. *B-D*, chests of abnormal cleared newborn rats, showing different degrees of fusion of the sternal centers of ossification.

In the normal newborn rat the osseous ribs take a parallel course downward and forward and the intercostal spaces are of almost equal width (Fig. 2*A*). In the abnormal specimens the intercostal spaces may be unequal (Fig. 2*B*) or certain ribs may touch each other (Fig. 2*C*) and show more or less complete fusion. Sometimes three or four fused ribs combine and form an osseous plate (Fig. 2*D*). The fusion is seen in the central or anterior parts of the osseous ribs and the posterior parts of the intercostal spaces remain open. The ribs

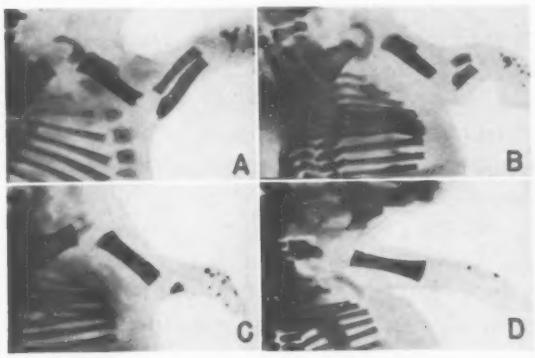

Fig. 4. *A*, arms of normal cleared newborn rat. *B-D*, arms of abnormal cleared newborn rats, showing increasing degrees of shortening to absence of radius and ulna.

V-VIII are most frequently affected, but occasionally other ribs show also the abnormal behavior described.

The sternum of the normal newborn rat consists of six well separated centers of ossification (Fig. 3*A*). In the abnormal specimens different degrees of fusion of these centers can be seen (Fig. 3*B-D*). Sometimes all the centers may be fused to a single osseous plate.

In the upper extremity the radius and ulna are frequently shortened and deformed (Fig. 4*B-C*) or the forearm of a cleared specimen may show no bone at all (Fig. 4*D*).

The tibia is most often abnormal and shows different degrees of shortening to complete absence of the bone (Fig. 5*B-D*). The fibula is less frequently affected but sometimes both the tibia and fibula are not

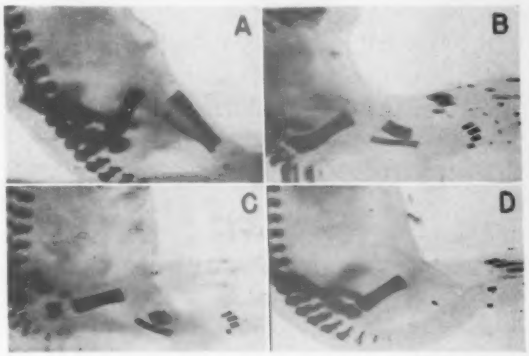

Fig. 5. *A*, leg of normal cleared newborn rat. *B-D*, legs of abnormal cleared newborn rats, showing increasing degrees of shortening to absence of the bones of the lower leg.

ossified and cannot be seen in the cleared specimen.

The paws and feet show a great variety of patterns which are the result of fusion or lack of development of the different small bones of the extremities.

Severe malformations of the soft tissues are seen relatively rarely in the abnormal

Fig. 6. Chest of abnormal animal which reached adulthood, showing permanent fusion of some ribs.

specimens but a few monstrosities have been observed. Gastroschisis, hemiatrophy, deformities of the eyes, etc. are occasionally encountered in the abnormal offspring.

Unfortunately the deformed animals are born dead or they die within forty-eight hours after birth. This makes it impossible to follow the further development of the malformations. That some of them are permanent can be shown by the roentgenogram of the chest of an abnormal animal which survived, was reared on an adequate diet and reached adulthood. It shows the fusion of the ribs to be a permanent malformation (Fig. 6).

TABLE III

	Total	Offspring Normal	Offspring Abnormal	Percentage Abnormal
Diet 1+2% pig liver	245	245	0	0
Diet 1	439	284	155	35.31

The histologic appearance of the abnormal structures can be demonstrated in sections of tibiae presenting different degrees of abnormality. They all show shortening of the osseous part and persistence of cartilage in places where normally ossification should have taken place. This delay in development, however, is not the only deviation from the norm. The abnormal tibiae are well developed in width but reduced in length and thus present abnormal shapes. The center of calcification which should develop in the center of the tibia is found near its posterior surface; this leads to abnormal arrangement of the bone trabeculae and further distortion of the normal histologic picture. It seems obvious that such abnormal structures will offer only diminished resistance to the pressure and stress of their neighboring structures and further malformation will result. Such histological studies may give us an insight into the formation of congenital abnormalities but at present only a beginning has been made in this direction.

The malformations of the offspring can be prevented easily by a change in the diet of the mothers. If 2 per cent pig liver is added to diet 1 entirely normal offspring are obtained.

When the same pair of animals is bred alternately on diet 1 and a similar diet which contains liver in addition, abnormal and normal offspring can be obtained alternately. The malformations described have been observed in the offspring of various strains of rats, when the mothers were fed the deficient diet 1.

These circumstances lead to the conclusion that we are dealing with a nutritional phenomenon. A nutritional factor absent in diet 1 but contained in large amounts in liver is apparently necessary for the normal intrauterine development of the fetus. Without this factor certain bones show arrest of development and malformations at the time of birth.

We do not know whether similar conditions ever occur in man and whether malformations encountered in our clinical work are ever due to a deficiency in the diet of the mother. However, if similar malformations should be observed in children, they will be seen by the roentgenologist first and his aid will be important in the diagnosis of the condition.

DISCUSSION

DR. GEORGE GUEST, Cincinnati, Ohio. The possible relevancy of these experimental findings to maternal and fetal human physiology of course merits thorough investigation. With this question in mind, it will be profitable to review whenever possible the health of mothers who have given birth to malformed infants.

In support of the thesis that congenital deformities in human infants may in fact result from faulty maternal nutrition, I should like to present a brief case report:

In 1934 an infant was admitted to the Children's Hospital with what appeared to be typical anemia neonatorum, with low red cell count (1 million per c. mm.) and hemoglobin content of the blood. He responded well to transfusions, but it was necessary to continue repeated transfusions over a period of several weeks. The failure to generate erythrocytes for

such a long period led to the conclusion that the condition was due to hypoplasia of the bone marrow. When erythropoiesis became adequate, however, there appeared to be no abnormality in the blood picture. Subsequently he had no further grave difficulty, but his development was always slightly below normal. At the age of four years he had a marked pigeon breast, although he had received sufficient vitamin D to prevent rickets. Roentgenograms at this time showed multiple ossification centers of the sternum, and fusion of the second and third ribs on the left side, near the costochrondral juncture; this fusion resembled that shown by Dr. Warkany in many of the young rats.

The mother of this infant became pregnant again two years later and then was found to have a severe microcytic hypochromic anemia; this cleared up promptly following the administration of iron. There is reason to believe she suffered with similar anemia in her earlier pregnancy.

Late in this pregnancy she moved from Cincinnati, and we learned afterwards that her infant was born at home, was thought to be normal, but suddenly became pale and died at the end of two weeks, without the benefit of blood examinations.

Anemias of pregnancy may be due to iron deficiency, to deficiency of the erythrocyte maturation factor of liver, or both. In this instance the anemia may have been concomitant with multiple nutritional deficiencies, since the mother's diet was practically vegetarian and she said she did not like meat.

The infant born to this mother had anemia apparently due to bone marrow dysfunction, and later was found to have one osseous defect which reminds us of those Dr. Warkany has demonstrated in rats born to mothers fed a deficient diet.

Such a finding may be purely accidental, but nevertheless it suggests a direction in which further investigations on the relationship between maternal and fetal nutrition might be carried out.

FALLOPIAN TUBE VISUALIZATION AS A TREATMENT FOR STERILITY*

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SINCE married couples hesitate to discuss the subject even with a physician, an estimation of the incidence of sterility is very difficult. Curtis[4] believes that it occurs in approximately 12 per cent of all marriages and the true figure is probably somewhat higher. The fault is as likely to occur in one partner as the other. Hunner and Wharton[10] state that certain German observers reported male sterility in 40 to 50 per cent of all cases studied before the first World War and observe that the compilation of accurate figures is almost impossible because the male so frequently refuses examination.

Certainly the proper study of each nonproductive union entails the examination of both mates. Male sterility falls outside the scope of this paper but it should be remembered that the condition may be due to constitutional disorders such as anemia, nervous exhaustion and endocrine imbalance; to outside influences such as exposure to heat or roentgen rays, or to infections such as gonorrhea and syphilis.

An imposing array of causes of female sterility can be found in the literature. Constitutional factors such as psychological difficulties, excesses, dietary errors, anemia and exhaustion play a rôle in this condition, but endocrine disorders are probably more important, and glandular changes producing amenorrhea and anovulatory menstruation should always be kept in mind.

The correction of local organic changes such as uterine hypoplasia, malpositions, perineal lacerations, vaginitis with acid secretions, pin hole os, cervicitis and fibroids has cured sterility in some instances, but these procedures frequently fail because of the presence of more important lesions in the fallopian tubes. Obviously conception cannot occur unless patency exists in at least one tube.

Various authorities state that tubal obstruction accounts for female sterility in one-fourth to two-thirds of all cases examined. The cause of the obstruction is rarely evident and significant points in the history are often withheld. Meaker[17] emphasizes the importance of simple spasm as an etiological factor but in our experience granulation tissue and fibrosis are usually present. Although these changes are produced by infection, the gonococcus is not always the causative organism. Other bacteria may be introduced by an abortion or a curettage, or a salpingitis may result from a peritonitis produced by a diseased appendix or some other intra-abdominal infection. In some instances the obstructions are due to congenital malformations and neoplasms.

FALLOPIAN TUBE STUDIES

The value of visualization of the fallopian tubes was recognized many years ago and Cary[2] published a technique using injected collargol in 1914. Similar techniques were described by Rubin[23] in 1915 and Dartigues and Dimier[5] in 1916. A 10 per cent solution of sodium bromide was recommended as an injection material in 1923 by Kennedy,[12] and Tussau[28] and Macquot[14] advocated a suspension of bismuth in 1925. These methods were not entirely satisfactory and the oxygen technique published by Rubin[24] in 1920 was the first practical procedure to come into general use. The harmlessness of oxygen injected into the abdomen by direct puncture for pneumoperitoneum studies was demonstrated by Stewart and Stein[27] in 1919, and Rubin began his injection studies in the same year. From 50 to 150 cc. was injected through a cannula inserted into the cervical canal and the patient was then examined roentgenoscopically in the erect position to determine the

* Read at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

presence or absence of gas beneath the diaphragm. When gas is placed between the diaphragm and the liver it produces severe pain in the shoulder, which appears each time the patient sits erect until all of the gas is absorbed. Oxygen remains in the abdomen for several days and the patient must be kept in the Trendelenburg position until absorption is complete to prevent the appearance of this pain. In 1921 Alvarez[1] showed that it was safe to inject carbon dioxide into the peritoneal cavity, and since it was absorbed very rapidly its advantages were obvious. Rubin found that small amounts of this gas were absorbed in a few minutes and this made the procedure much simpler. The rapid absorption factor also did away with the danger of gas embolism.

Other investigators such as Rabbiner,[21] in an effort to further simplify the test, have advocated the use of air as an injection material. This practice should, in my opinion, be strongly condemned. Air is made up for the most part of nitrogen which remains in the peritoneal cavity for several weeks and may produce shoulder pain during that entire period. However, the most serious objection is the danger of air embolism. This complication has produced sudden death and no patient should be subjected to such a danger.

Although the gas tests were of great value they gave no graphic information relative to the anatomy of the fallopian tubes. The advent of the iodized oils solved this problem and Heuser[7] published the first satisfactory roentgenograms made following the injection of lipiodol into the uterus in 1925. It soon became evident that closed tubes might be opened with injected oil and our own technique[15] first published in 1939 utilizes a combination of the two procedures.

TECHNIQUE

Since ovulation is supposed to take place about nine or ten days after the completion of normal menstruation most authors agree that the test should be undertaken on the seventh or eight postmenstrual day. The examination is carried out as an office procedure, and a preliminary cleansing of the lower bowel and evacuation of the bladder are advised. The patient is placed in the lithotomy position on a Potter-Bucky diaphragm supported by a drop leaf table equipped with detachable stirrups, as illustrated in Figure 1. After a bivalve speculum has been inserted the cervix is well illuminated with light from a head mirror and painted with tincture of iodine. The

Fig. 1. Drop leaf table, instruments and equipment set up for tubal insufflation and salpingography.

anterior lip is then grasped with a single tenaculum forceps placed so that the handles rest in a horizontal plane and the cervical canal is located with a small Hegar dilator. The cannula illustrated in Figure 1 is next inserted into the canal so that the rubber acorn rests firmly against the face of the cervix. The two hooks which are attached to the cannula by a set-screw are inserted into the handles of the tenaculum, pulled downwards and locked so as to assure a tight fit between the acorn and the cervical canal. After a small amount of carbon dioxide gas has been allowed to pass through the long rubber tube it is attached to the cannula by means of a Luer connection. The small needle valve on the gas tank is opened and the pressure as indicated by the mercury manometer is allowed to build up very slowly. If the fallopian tubes are

FIG. 2. Inverted position used for the demonstration of pelvic structures after the introduction of carbon dioxide into the peritoneal cavity.

patent the siphon volumometer will show that gas is passing through the system into the peritoneal cavity at pressures varying between 80 and 120 mm. of mercury. When the tubes are partially closed the passage of gas will be observed at much higher pressures. In the event that patency is demonstrated by this method, about 500 cc. of carbon dioxide is allowed to flow into the abdomen. The presence of intraperitoneal gas is then demonstrated by the simple procedure illustrated in Figure 2. After the patient has been placed in a prone position the stirrups are removed and the lower end of the Potter-Bucky diaphragm is raised so that a 23 degree angle board can be placed under it. The addition of a foot stool to support the feet throws all of the gas into the pelvis and eliminates the symptoms produced by subphrenic gas. A roentgenogram made with the tube angled 20 degrees towards the head and centered over the coccyx renders the uterus, adnexa and broad ligaments visible, as illustrated in Figure 3.

When, after three attempts, no gas is seen to pass into the abdomen, the rubber tube is disconnected from the cannula and replaced by a Luer syringe containing 10 cc. of lipiodol. Pressure is gently applied to the plunger until 5 cc. of the oil has entered the uterus. The valve at the end of the cannula is then closed, the syringe detached, and a roentgenogram made in the anteroposterior position. If, as is usually the case, the developed film reveals no oil passing completely through the tubes, a second exposure is made following the injection of an additional 2.0 cc. of lipiodol. If the tubes are not completely filled following this procedure, it is repeated as often as progress can be demonstrated. The increased uterine pressure is maintained throughout the entire test by closing the valve at the end of the cannula after each injection. When the uterus and cervical canal show dilatation and the heads of the oil columns in the tubes do not advance, following one of the fractional injections, the test is abandoned. However, a subsequent roentgenogram is always made twenty-four hours later because the peristalsis in the tubes will sometimes force the oil into the peritoneal cavity after the pressure has been released. Gentleness and patience are essential to the

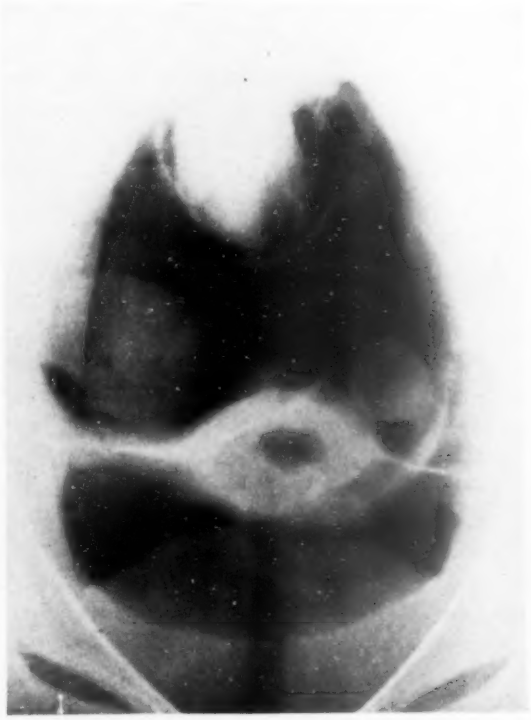

FIG. 3. Roentgenogram made in inverted position after introduction of 500 cc. of carbon dioxide by the intra-uterine route.

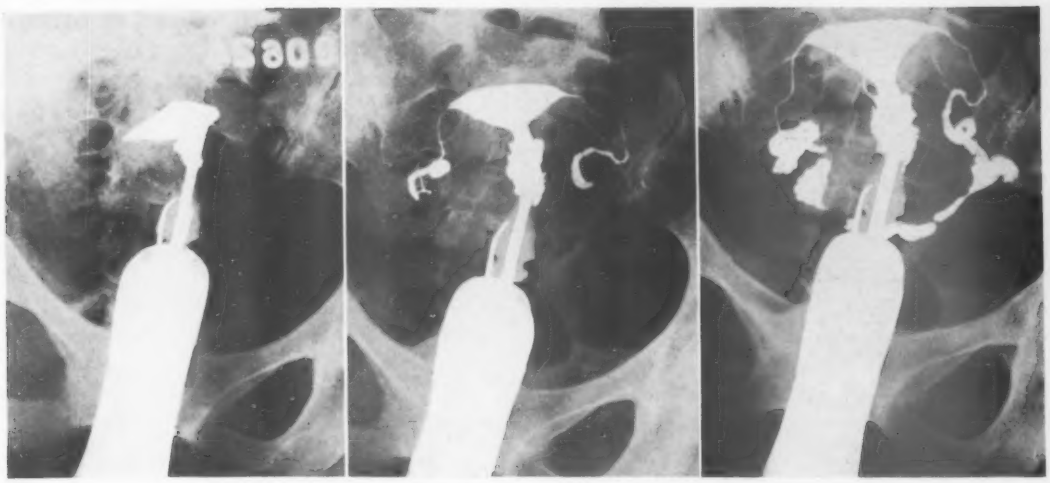

Fig. 4. Roentgenograms made after the introduction of totals of 5, 7 and 10 cc. of lipiodol into the uterus with the increasing pressure maintained during the entire test. Free oil was finally demonstrated in the peritoneal cavity and pregnancy occurred six months later.

success of this procedure and the pain produced is not severe enough to require medication in most instances. Free droplets of oil indicating patency can be demonstrated about the ends of a surprisingly large number of completely obstructed tubes after the second or third injection. It is my opinion that the slowly increasing oil pressure is more effective in opening up adhesions than the repeated application of gas pressure for short periods of time.

No attempt has been made to utilize the kymograph which is so highly recommended by Rubin. The information obtained by this instrument is at best indirect and errors such as those produced by leakage about the acorn may creep into the recorded tracings.

COMPLICATIONS

Although carbon dioxide is generally conceded to produce no untoward reaction

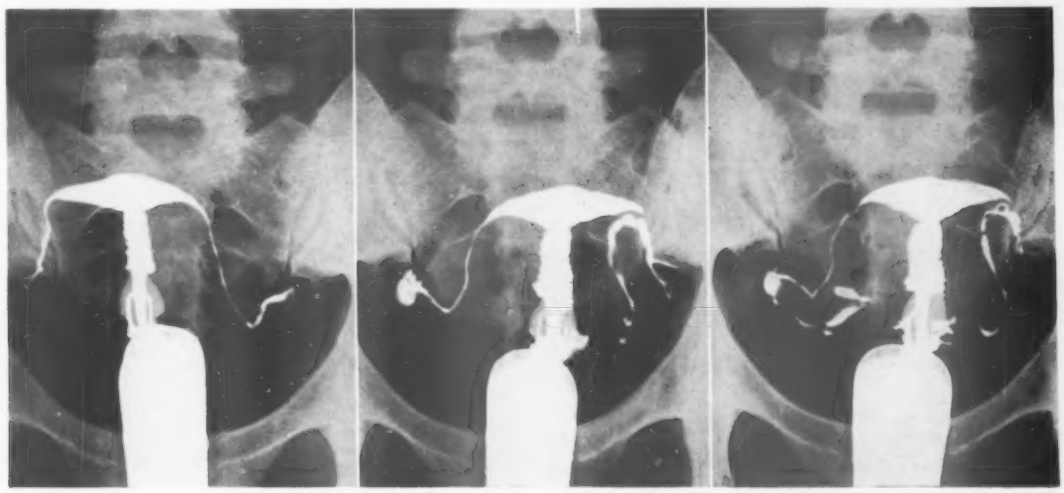

Fig. 5. Roentgenograms made after introduction of totals of 5, 7 and 10 cc. of lipiodol into the uterus. An opening was finally established in one tube and pregnancy occurred three months later.

in the peritoneal cavity, many have condemned the use of iodized oil which is usually not absorbed for many months. Cases of peritonitis have been observed following salpinography by Hoffmann,[9] Odenthal,[20] Gauss,[6] Hirst,[8] Rubin,[25] Curtis,[3] Rabbiner,[21] and Novak.[19] Gauss and Hirst report deaths attributed to infection produced by injected iodized oil. Most of these disturbing articles appeared in the foreign literature more than ten years ago.

No mishaps have occurred in our series of 101 cases and American physicians have for the most part taken an optimistic attitude. Steinharter and Brown[26] and Jarcho[11] state that they have observed no serious complications following the use of iodized oil. Newell[18] could find no evidence of irritation in the tubes or peritoneal cavity at operations done on 30 cases following the injection of iodipin, and Masmonteil[16] made similar observations on operated patients examined with lipiodol. The most convincing report was made by Robins and Shapira[22] who had no mishaps in 1,000 cases except in one patient in whom a ruptured hydrosalpinx occurred and this complication was easily remedied at operation. They

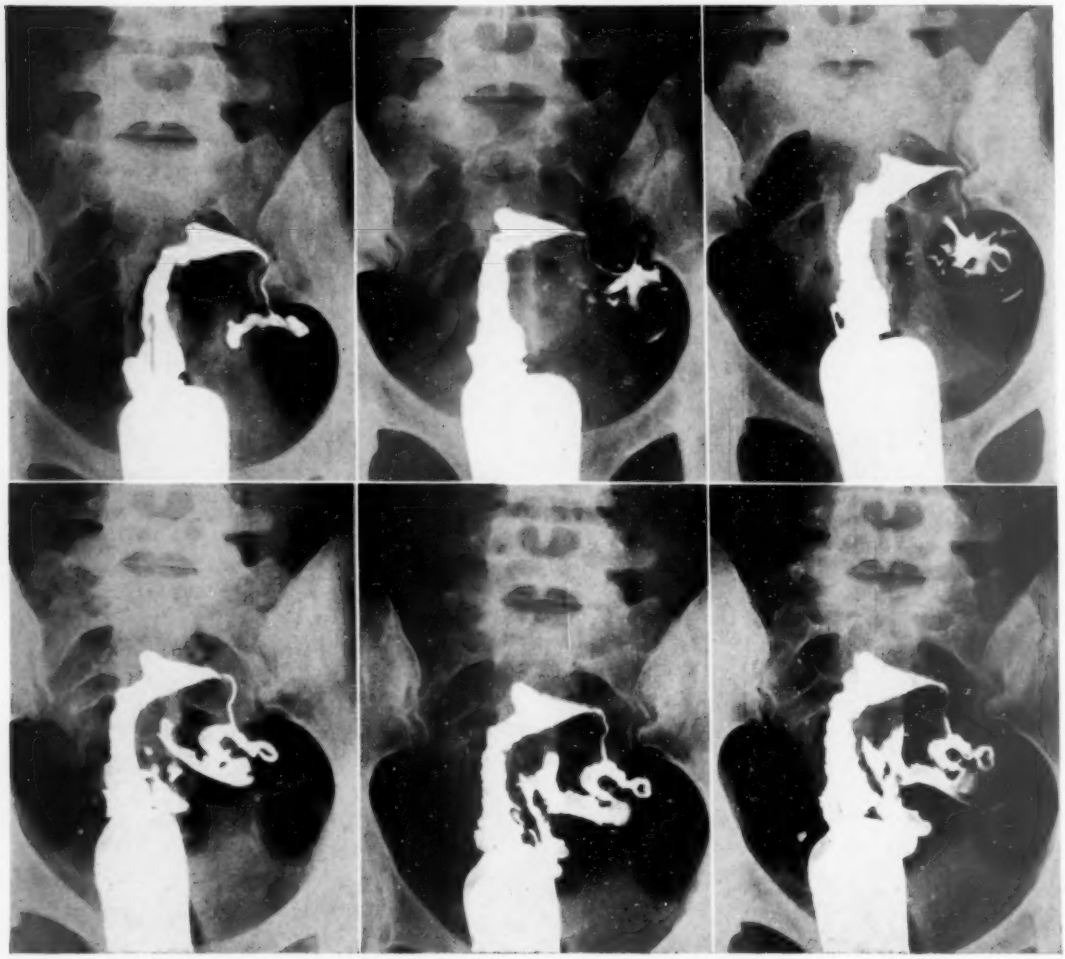

FIG. 6. At the first test illustrated in the upper row of roentgenograms one tube was found to be obliterated and no opening could be established in the other one after using a sustained increasing pressure for thirty minutes. At a second test done three weeks later and illustrated below, oil was forced through the adhesions about the left tube and pregnancy occurred three months later.

were also able to show that entrance of lipiodol into the blood vessels and musculature of the uterus produced no ill effects in 18 cases. They state: "We are quite convinced after these experiences that lipiodol does not harm the normal membranes of the uterus or tubes and does not set up any peritoneal irritation." Leventhal and Solomon[13] observed an exacerbation of an old pelvic infection in only one case in a series of 85 patients examined and quote I. F. Stein as stating that no morbidity and no pelvic abscesses were observed in a series of 500 cases receiving lipiodol injections. These authors also report a personal communication from Reis and De Costa to the effect that a histological study of 30 fallopian tubes removed following salpingography revealed no changes attributed to the use of lipiodol. From these reports it seems reasonable to assume that lipiodol is in itself quite harmless, but that an old infectious process may be activated by the mechanics of fallopian tube injection.

CONTRAINDICATIONS

If reactions are to be avoided cases suitable for fallopian tube studies should be selected with some care. Rubin lists as contraindications inflammations of the genital tract, menstruation and the premenstrual phase, abnormal bleeding from the genital tract, pregnancy, severe constitutional diseases and neurosis. Of these conditions, acute and subacute pelvic inflammations are most important, and Rubin advises preliminary white blood counts, vaginal and cervical smears and sedimentation tests when such complications are suspected. Since lipiodol passes readily into open blood spaces a recent curettage also should be considered a contraindication.

RESULTS

Both insufflation and salpingography were first devised as diagnostic procedures, but reports of pregnancies occurring following the production of tubal patency began to appear in the literature about ten years ago. Leventhal and Solomon have recently published the results claimed by thirteen different authors and these figures are given in Table I. Some used only gas insufflation while others depended entirely upon lipiodol injections. Unfortunately some of the figures are based on all of the cases examined while others represent the percentages of the pregnancies occurring in groups of patients in whom patency was established. It is interesting to note that

TABLE I

PERCENTAGE OF PREGNANCIES FOLLOWING PATENCY TESTS

(From Leventhal and Solomon[13])

Gas Insufflation	
Rubin	17.5
King	11.6
Chatillon	15.2
Bonnet	18.4
Stein and Leventhal	26.3
Average	17.8%
Lipiodol Instillation	
Francillon-Lobre and Dalsace	20.5
Robins and Shapira	32.0
White	32.5
Béclère and Francois	18.0
Volk	25.0
Wilson	26.3
Brault and Tizon	26.0
Schultze	25.0
Average	25.6%

the results were somewhat better when oil was injected than when gas was used. Leventhal and Solomon, who used lipiodol in all patients for whom a gas insufflation failed, reported success in 40.8 per cent of 133 picked cases of sterility. Each woman examined was advised to have normal coitus just before her office appointment. In some instances where stubborn tubal blockage was encountered an attempt was made to increase the intra-uterine pressure with an injection of surgical pituitrin. Their encouraging results seem to favor the use of the combined technique.

In our own clinic 101 sterile women have been examined with the combined technique previously described in this paper. Patency of at least one tube was established in 75 cases and conception occurred

later in 27, or 36 per cent of the patients in this group. The successful cases are tabulated in Table II. Normal pregnancies ensued in all except Case XIV. In this woman no patency could be demonstrated but ectopic gestations occurred first in one tube and then in the other at periods of two and in all except 4 patients, and some gynecologists contend that they should be eliminated from the successful group but since the fallopian tubes were completely obstructed in all four the rôle of the establishment of patency cannot be ignored. It is worthy of note that in 17 of the 27 women

TABLE II

STERILE PATIENTS BECOMING PREGNANT AFTER TUBE EXAMINATION

Case No.	Patient	Sterile Period	Time from Test Until Conception	Number of Tests	Successful Injection Material
I	L.H.R.	3½ yr.	5 mo.	1	Lipiodol
II	F.B.	2 yr.	6 mo.	1	Lipiodol
III	J.S.	1½ yr.	8 mo.	1	CO_2
IV	W.M.	4 yr.	3 yr.	2	Neither
V	W.E.A.	4 yr.	1½ yr.	1	CO_2
VI	B.H.	5 yr.	3¾ yr.	1	Lipiodol
VII	A.S.	8 yr.	4 mo.	1	Lipiodol
VIII	H.G.M.	2½ yr.	6 mo.	2	Lipiodol
IX	G.E.B.	?	Immediate	1	Lipiodol
X	D.S.	4 yr.	1 mo.	3	CO_2
XI	L.H.L.	4 yr.	1 mo.	1	CO_2
XII	M.H.G.	?	1 mo.	1	Lipiodol
XIII	L.Y.	8 yr	2 mo.	1	Lipiodol
XIV	K.C.	5 yr.	Ectop. 2½ yr. Ectop. 3 yr.	1	Neither
XV	J.W.	3 yr.	1 mo.	1	Lipiodol
XVI	D.H.	3 yr.	Immediate	1	CO_2
XVII	W.I.	2 yr.	8 mo.	2	Lipiodol
XVIII	J.M.M.	4 yr.	1 mo.	1	CO_2
XIX	H.L.	2⅓ yr.	5 mo.	1	Lipiodol
XX	M.S.	5 yr	Immediate	1	Lipiodol
XXI	G.S.	8¾ yr.	2 mo.	1	CO_2
XXII	A.H.G.	9 mo.	3 mo.	1	CO_2 and lipiodol
XXIII	W.L.B.	2⅓ yr.	6 mo.	3	Lipiodol
XXIV	B.H.	6 yr.	3 mo.	2	Lipiodol
XXV	H.J.F.	2 yr.	1 mo.	1	Lipiodol
XXVI	F.R.N.	4 yr.	2 mo.	1	Lipiodol
XXVII	W.H.B.	8 yr.	2 yr.	3	Lipiodol

one-half and three years after the test was carried out. Patency was established at the first visit in 20 cases but two tests were performed in 4 patients and three tests in 3 others. The ultimate success obtained where multiple examinations were done makes it seem likely that the figures could have been improved if more patients had subjected themselves to repeated tests. Rubin states that repeated insufflation will often bring about a cure. Conception occurred within eight months after the test becoming pregnant lipiodol was forced through the tubes by the slow pressure method after the CO_2 method had failed.

CONCLUSIONS

1. Patency of at least one fallopian tube can be produced in about three-fourths of all women with blocked tubes by using a combined CO_2 and lipiodol technique.

2. A normal pregnancy can be expected in about one-third of the cases in which such patency is established.

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THE METHODS AND EFFECTS OF PREOPERATIVE IRRADIATION IN THE TREATMENT OF OSTEOGENIC SARCOMA*

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INTRODUCTION

AN IDEAL situation would arise if we could measure the exact dimenions of a bone tumor, predetermine its radiosensitivity, and from a graph or table outline in specific factors the dose of high voltage roentgen rays to be given. At the present time there are so many variable factors, and so many indeterminate or nonmensurable factors, that each case must be studied individually and treatment outlined on more or less empiric grounds in the hope of attaining the desired destruction of tumor without irreparable loss of normal tissue.

A sufficient number of cases has been studied to justify one basic conclusion, namely, that at least 4,000 roentgens must be delivered to all parts of a tumor to destroy it. This, then, constitutes a fixed minimum factor in determining dosage. By carefully planning and studying other factors we may ultimately be able to acquire sufficient data to achieve the desired results in a greater proportion of patients treated.

In the attainment of five year survival it has been shown[1] that irradiation alone gives the least satisfactory rate of 8.5 per cent; surgery alone yields a 31 per cent five year survival rate, while the combination of preoperative irradiation and radical surgery gives the encouraging survival rate of 34 per cent.

In the recent six year period from January 1, 1935, to January 1, 1941, 114 patients with osteogenic sarcoma were admitted to the bone tumor department of the Memorial Hospital for treatment. Fourteen of these patients lack microscopic proof of the disease and in 31 irradiation methods were not employed, leaving 69 proved cases available for this analysis of irradiation methods and their effects.

METHODS OF TREATMENT

For the most part, in this series the fractionated dose technique was employed at 200 kv. in 44 cases, at 250 kv. in 15 cases, and at 1,000 kv. in 3 cases. In 9 cases the 4 gram radium element pack was used and in 2 cases the massive dose technique with roentgen rays was employed. We do not propose in this presentation to evaluate the relative merits of these different techniques. The radium pack and the massive dose technique have their theoretical advantages which must be analyzed and dealt with in a separate paper.

The fractionated dose method has been employed more or less routinely for several reasons. It permits greater accuracy in keeping just at, or below, skin tolerance. The skin can be watched constantly and treatment discontinued when the maximum effect is obtained or it can be continued beyond a proposed dose if the skin tolerates the treatment better than expected; furthermore a far greater total dose can be delivered to the tumor.

The management of the case should follow a definite line of procedure. After obtaining a careful history, a complete physical examination, serologic and blood chemistry determinations, and roentgenographic examination of the chest for possible pulmonary metastasis, a tentative diagnosis is made on the combined findings. Microscopic confirmation is obtained by aspiration biopsy, and occasionally, if necessary, by formal operative biopsy. The preoperative roentgen therapy is then planned.

[1] Coley, B. L., and Pool, J. L. Factors influencing the prognosis in osteogenic sarcoma. *Ann. Surg.*, 1940, *112*, 1114–1128.

* Read at the Twenty-sixth Annual Meeting, American Radium Society, Cleveland, Ohio, June 2–3, 1941.

From a study of the roentgenogram it is determined whether treatment shall be given at one or two levels. Where there is extension of tumor up the shaft of the bone, it is necessary to include two levels—upper and lower—to cover adequately the disease. One next considers the involved extremity and determines how the circumference may be conveniently divided into satisfactory portals of standard size. Only two portals—anterior and posterior, or medial and lateral—may be available at each level, or three or even four portals may be utilized (Fig. 1).

The subsequent amputation should always be performed well above demonstrable tumor. With the exception of the lower end of the femur, in which cases subtrochanteric amputation is advisable, the level of amputation should be through, or just above, the joint proximal to the tumor. Therefore, the choice as to the level of amputation is seldom influenced by the preoperative irradiation.

Due consideration must now be given, particularly in extremities of smaller diameters, to the exit dose. This desideratum will influence chiefly the choice of voltage and target-skin distance. Sometimes a rough sketch, to explore the potentialities of different voltages, is helpful. The only remaining variable factor is the number of roentgens to be given at each treatment, and this is a matter of critical judgment. The usual fractions employed are 200, 250, 300, and 400 roentgens and one must strike a safe balance between the total dose desired and the estimated skin tolerance. When upper and lower levels are being treated patients tolerate treatment over one upper and one lower portal per day. Otherwise single daily treatments are given (Table 1).

The size of the tumor is probably the most important single determinant in estimating all the factors suitable to a given case. With a small tumor the diameter of the region is minimal and therefore the exit dose must be carefully considered in estimating treatment to be given from the opposite side. This hazard may be partially obviated where two additional portals are outlined obliquely to the initial portal. With very large tumors the portals are likely to be of maximum size so that smaller daily doses of about 200 roentgens may be indicated. On the other hand, a larger total tumor dose may be necessary if all portions of the tumor are to be adequately irradiated. The deeper penetration of the higher voltages, and greater target-skin distances, are distinct advantages in such circumstances.

Fig. 1. Osteogenic sarcoma in the lower end of the left femur, female aged thirteen. Photograph shows the portals as outlined for preoperative irradiation with the 250 kv. unit at 50 cm. target-skin distance; 200 r was given daily to each of two portals for a total of 2,400 r to each portal.

The majority of the lesions treated were in the long tubular bones (femur, 36; humerus, 11; tibia, 3; fibula, 2), and treatment was outlined as above. However, osteogenic sarcoma is not uncommon in other locations and in this series the ilium was involved in 6 cases, sacrum in 3, scapula in 2,

sternum in 2, and one each in the ischium, pubis, rib, and vertebra. These regions call for careful planning and frequently for considerable ingenuity, but always along the lines and principles as stipulated above to obtain the maximum depth dose with due regard to the skin and adjacent structures.

The age of the patient may greatly influence the choice of some of the treatment factors. In children the use of 200 kv. is indicated because of the smaller size of the limb. Larger total doses may be given as children stand irradiation well and the daily recovery factor is greater. With smaller average portals the daily fractionated dose may be greater, e.g. 400 roentgens per portal per day. In elderly patients osteogenic sarcoma is often on the basis of Paget's osteitis deformans and neither the bone nor the skin tolerates maximum doses of roentgen rays well. Therefore it is advisable to watch closely for the upper limits of tolerance.

In all cases it is advisable to obtain consent for amputation where indicated before roengen treatment is completed. It is justifiable to carry the treatment to the upper limits of tissue tolerance where the treated region is to be removed surgically. Whereas if no amputation is to be permitted one must bear in mind undesirable late irradiation effects should the tumor respond favorably to the treatment.

Six patients were given diathermy to the tumor before each treatment on the hypothetical basis of augmenting the irradiation effect by increasing the circulation in the tumor and hence its sensitivity. A 300 watt short wave machine of 6 meters wave length was used for this purpose and treatments of ten or fifteen minutes were given immediately before each high voltage roentgen treatment. The results will be discussed later.

TABLE I

SUMMARY OF TREATMENT GIVEN IN A TYPICAL CASE

Date	Region Treated	Number of Treatments	Roentgens	Kv.	Filter mm. Cu	Target-Skin Distance cm.	Field	Current ma.	Time min.
1/5/39	Lower right femur —anterior	15	200	200	0.5	50	7×20 cm.	30	3.3
to	Lower right femur —medial	15	200	200	0.5	50	7×10 cm.	30	3.3
2/3/39	Lower right femur —lateral	15	200	200	0.5	50	7×10 cm	30	3.3

Male, aged twelve, with osteogenic sarcoma of the lower right femur. Total dose to tumor, 8,000 roentgens. Diathermy treatment (ten minutes) given daily before each roentgen treatment. Two portals treated daily.

EFFECTS

(*a*) *On Symptoms.* It is impossible to measure in concrete figures the effect of irradiation on the symptoms presented by the patient. Too much depends upon the personal equation. However, we are permitted to draw some conclusions from our direct contact with the patient. Pain is the predominating symptom and it is a universal experience to note partial or complete relief of pain in practically all cases. This degree of relief varies with the individual and with the type of osteogenic sarcoma; the permanence of the relief of pain is a fairly reliable indicator of the degree of control attained. We have observed relief as early as one or two days after the first roentgen treatment, more commonly about two weeks after daily treatments were begun, and occasionally four or five weeks after the termination of a treatment cycle.

Disability is usually proportionate to the amount of pain experienced by the patient and is often a protective response in avoiding painful movements. Therefore, disability may improve in proportion to the relief of pain effected. In this connection a word of caution is in order—if a weight-bearing bone has been extensively invaded by a tumor growth so that there is danger of a pathological fracture, adequate support must be supplied in the form of a plaster cast or a steel brace to obviate this hazard, for the improvement effected may give the patient a false sense of security or strength in the involved extremity.

Lost weight may also be regained with the relief of pain and consequent improvement of appetite and sleep.

(*b*) *On Skin.* In dealing with a lethal disease the treatment must at times be courageous. It will not salve the conscience of any of us to administer mild palliative measures only to create the impression upon the patient and his family that something is being done. Our plan of treatment must be directed towards the cure of the disease while it is still in its early stages. In most instances this will call for a program of preoperative radiation therapy aimed at destroying or partially sterilizing the tumor without jeopardizing the skin at the level of the proposed high amputation. As a first prerequisite a large total dose must be delivered to all parts of the tumor. The skin will tolerate only a certain amount of radiation. The dose per portal must be carried up to, but not beyond, the limits of skin tolerance. A distinct erythema with slight vesiculation is desirable but marked vesiculation, ulceration and deeper skin layer destruction must be carefully avoided.

In this way we are limited as to the total dose per portal and therefore we endeavor to employ multiple portals over and around the tumor to increase the total tumor dose. Here the exit dose from the opposite portals must be taken into consideration and overdosage guarded against, particularly in employing the higher voltages.

The time interval between the last roentgen treatment and amputation will vary according to the skin reaction and consequent healing but usually from two to six weeks is required.

(*c*) *On Rate of Growth.* There are many subvarieties of osteogenic sarcoma with wide variation in radiosensitivity. There is even considerable variation in radiosensitivity in some tumors of the same subgroup. While, in general, the osteogenic chondrosarcomas are markedly radioresistant, occasionally a satisfactory response is obtained. The sclerosing type is also usually quite radioresistant. On the other hand, the periosteal and subperiosteal types as well as the cortical and medullary osteolytic lesions may show remarkable response to irradiation (Fig. 2). Some tumors from the start show a tendency to rapid growth which may or may not be impeded by irradiation. Others, such as the central medullary fibrosarcomas, tend to grow slowly and growth may be somewhat inhibited by irradiation. We have found that in children the sarcomas are more anaplastic and hence more radiosensitive but tend to metastasize early. In adults the tumors are apt to be more differentiated, more radioresistant, and in most of these cases early amputation is recommended without preoperative irradiation.

(*d*) *On Tissue.* To ensure satisfactory tissue response all portions of the tumor must receive an adequate dosage. By carefully planning the treatment portals and insuring an adequate depth dose it is possible to effect a degree of destruction or irradiation change which can be determined on microscopic examination of the removed tissue. Considerably more investigation along these lines is required and such an investigation is proposed, but in this preliminary report 16 cases of this series showed microscopic evidence varying from "good irradiation effect" to "complete sterilization." In some of these the pathological report was: "marked irradiation change, no viable tumor in some areas, nearly total destruction, extreme irradiation change,

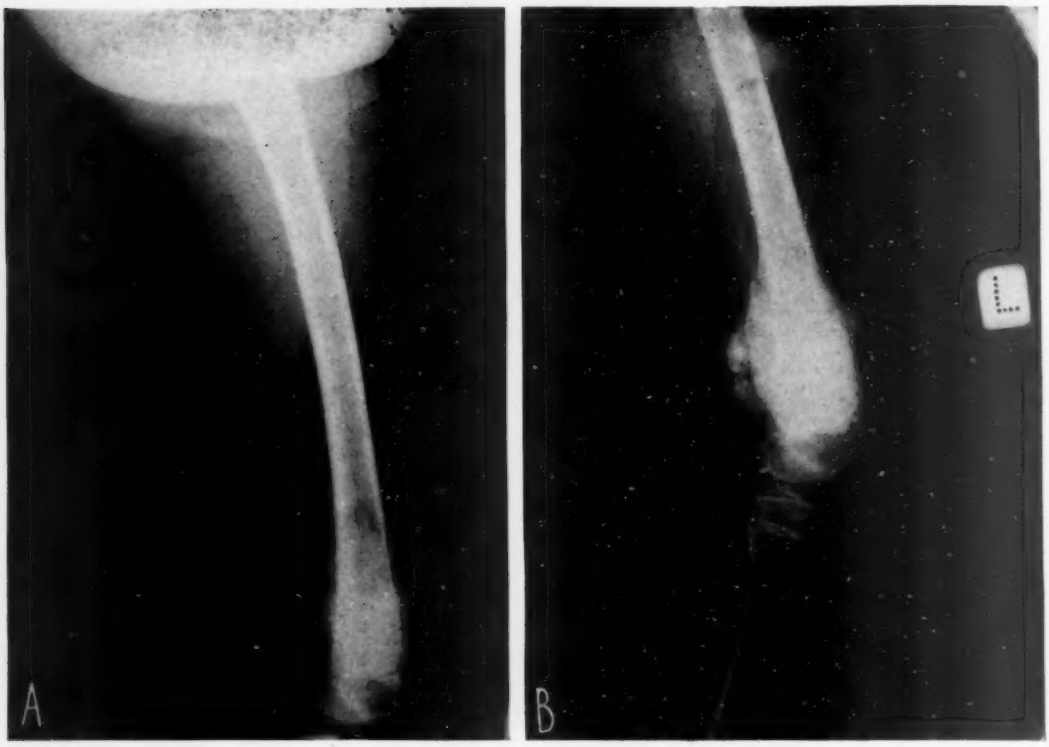

FIG. 2. *A*, osteogenic sarcoma of the lower left femur, female aged seven. Preoperative irradiation given with the 200 kv. unit at 50 cm. target-skin distance; 200 r given daily to one of three portals and each treatment preceded by ten minutes of diathermy. *B*, roentgenogram taken two weeks after the last roentgen treatment showing marked response to a total tissue dose of 9,000 r.

etc." One must not be misled by a pathological report of complete sterilization for to be convincing this reaction would have to obtain in each of all serial sections cut through the entire tumor mass and this was not done in these cases. However, it is some indication that more effective irradiation is being provided, for with earlier treatment techniques such reports were rare.

In these 16 cases showing some degree of irradiation effect in the tumor, the largest tissue dose was 9,000 r and in 11 cases the total dose to the tumor was over 4,000 r. Two cases treated with the 250 kv. machine received 3,500 and 3,800 r to the tumor, and one case treated with the million volt machine received only 2,800 r to the tumor. Two other cases with doses under 4,000 r had diathermy before each treatment. From this it would appear (although not conclusively in a small series) that somewhat greater effect may be expected when the higher voltages can be used or if diathermy is employed. Of the 6 cases treated with preliminary diathermy 2 showed no irradiation effect in the tissue and the other 4 showed marked effect.

(*e*) *On Phosphatase.* It has been shown[2] that in patients with osteogenic sarcoma having elevated serum phosphatase values, the changes in phosphatase afford a prompt indication of the effect of radiation therapy. Adequate amounts of radiation cause an appreciable drop in the serum phosphatase through partial or complete inactivation of the phosphatase-producing mechanism in the tumor. Where amputation follows the irradiation cycle there is a further drop in the serum phosphatase to normal levels,

[2] Woodard, Helen Q., and Higinbotham, N. L. Serum and tissue phosphatase determinations as an aid in evaluating the radiation therapy of bone tumors. *J. Am. M. Ass.*, 1941, *116*, 1621–1627.

if there are no metastatic foci to liberate sufficient phosphatase to again raise the serum level. In 18 cases in this series, complete studies of initial serum phosphatase, post-irradiation values, and post-amputation values are available. The average initial value for the 18 cases was 18.5 units. The average value after irradiation dropped to 9.2 units, and after amputation the average normal level of 5.6 units was reached.

In one case the value rose from 7.6 units on admission to 9.3 units after irradiation and to 14.5 units after amputation. Although pulmonary metastases were not demonstrated until six months after amputation, it is reasonable to assume that these values were irregular, due to the age (fifteen) of the patient, failure to control the tumor by a small amount of radiation (1,700 r), and early metastasis that did not become evident until well advanced. On the other hand, one patient aged seven showed very marked typical serum phosphatase changes and from an initial reading of 83.5 units the value dropped to 13.5 units after 9,000 r to the tumor, and to 8.5 units after amputation. Three months later the serum phosphatase had risen to 30 units and pulmonary metastases were demonstrated which soon caused the death of the patient (Fig. 2).

CONCLUSIONS

In view of the small number of five year survivals, irradiation alone should not be relied upon in the treatment of osteogenic sarcoma. In some instances, notably adults with radioresistant tumors, immediate amputation remains the treatment of choice. However, some osteogenic sarcomas are somewhat radiosensitive and in these cases the treatment should be: carefully planned preoperative radiation therapy followed by amputation. In inoperable cases irradiation alone may be given for its palliative effect.

The program of irradiation must be arranged to suit the requirements of the individual problem presented, and kilovoltage, daily dosage, and size of portal must be balanced against the size of the tumor, estimated skin tolerance, and a proposed total tissue dosage of at least 4,000 roentgens. This radiation effect might possibly be increased by the use of diathermy preceding each roentgen treatment.

Estimation of phosphatase activity has become a reliable index of the completeness of inactivation of a tumor by irradiation, or eradication by removal, in patients in whom the initial serum phosphatase is elevated.

Post-amputation irradiation has not been considered as it is very seldom, if ever, indicated. Recurrence in the stump is exceedingly rare after *high* amputation. This type of tumor does not metastasize to, or through, the lymph nodes. Irradiation of the lung fields for pulmonary metastasis is of questionable value, either prophylactically or therapeutically.

SUMMARY

In the past five years 114 cases of osteogenic sarcoma have been admitted to the bone tumor clinic of the Memorial Hospital. The methods of irradiation employed are discussed and the effects of the irradiation on symptoms, skin, rate of growth, tumor tissue, and phosphatase level evaluated.

DISCUSSION

Dr. Harry Hauser, Cleveland, Ohio. It seems to me that encouraging results are being found in a discouraging disease; with the statistics of 34 per cent five year survival rate in osteogenic sarcoma as reported by Coley and Pool in combined radiation therapy and amputation, I believe we have something to think about.

It is a question as yet, in my mind, as to whether or not radiation therapy is worth while in the dosages described by Dr. Higinbotham today. It seems to me that with only a 4 or 5 per cent increase in five year survival rates and in such a small group of cases (relatively small) statistically we do not know as yet whether or not radiation therapy has a beneficial effect.

I say this group is small realizing that it is probably one of the largest groups of any clinic in this country.

I would like to emphasize the selection of the type of osteogenic sarcoma for radiation therapy. I think Dr. Higinbotham pointed out clearly that all cases were not routinely irradiated. Those osteolytic types and the bulky soft tissue types probably respond somewhat better than the sclerosing varieties.

I think the technical factors employed are perfectly satisfactory and the total dosages employed are about as adequate as can be obtained with present types of apparatus.

I would like to ask Dr. Higinbotham a few questions before I close. First, what technique is employed in the treatment of those lesions not located in the long bones, such as lesions in the ischium, ribs, or sternum where cross-firing is a rather difficult procedure?

I would like to ask whether or not some patients with lesions in the distal portion of the extremities such as the tibia were not purposely over-irradiated or whether that idea has been given consideration.

In dosages up to 10,000 or 15,000 roentgens, with the size of field that Dr. Higinbotham mentioned, were amputations being done before necrosis entered the picture? I wonder whether there is any value in that type of irradiation.

In closing, it seems to me that Drs. Higinbotham and Coley have presented a method here and have shown effects of these methods, but it will be some time in the future before we know whether these methods are really worth while or not.

DR. HIGINBOTHAM (closing). In answer to the question as to why irradiate a tumor that you are going to amputate, we have been asked that same question repeatedly and we still haven't a satisfactory answer. The only reason I can give is that from a study of cases treated over a long period of time, as presented in a recent paper published by Coley and Pool, the cases that had had irradiation plus amputation showed a slightly better survival rate than the others.

We still have no adequate explanation of why preoperative irradiation in some cases improves the results. Our statistics present the fact, the reason for which remains a problem for further research and speculation. That does not mean that irradiation plus amputation is indicated in every case of osteogenic sarcoma. We believe that there are a number of cases which are not radiosensitive at all and a prompt amputation should be done. There are a number of others that are partly radiosensitive and we believe they should be given the benefit of irradiation followed by amputation. There are a few patients who refuse amputation and these we can treat with irradiation giving us a group of patients to form the basis of analysis of cases treated by irradiation alone.

Dr. Hauser asks if we have ever given an excessive dose of roentgen radiation to an extremity where we know amputation is going to be performed. Yes we have, but we have done it in so few instances that it would be impossible to draw any conclusions as to the effect. As I pointed out in my paper the largest total tumor dose was 9,000 roentgens. I believe that, with caution, we can increase the dosage still further and eventually carry out the idea that Dr. Hauser has asked about, in a larger number of cases.

There are not very many bone tumors extant in the country at any one time so it is not easy to work up a large series of representative cases in a short time. However, over a long period, we should be able to arrive at some very valuable conclusions.

Vol. 47, No. 6

RADIUM TREATMENT OF CANCER OF THE BLADDER

REPORT OF 267 CASES*

By CHARLES C. HERGER *and* HANS R. SAUER

BUFFALO, NEW YORK

CONSIDERABLE diversity of opinion has been expressed in recent publications as to the value of interstitial radium irradiation in the treatment of bladder tumors. Some authors recommend the use of radon implants as the method of choice, while others favor the use of radium irradiation only for a limited number of cases either alone or in combination with other methods of treatment. On the other hand, some advocate the abandonment of the use of radium because, in their opinion, the results accomplished are not in proportion to the ill-effects produced.

It is our opinion that interstititial radium irradiation either employed alone or in combination with other methods of treatment yields good results in certain selected cases. Each case, however, should be considered individually before a decision is made as to whether or not radium implantation is advisable.

During the period from January 1, 1930, to December 31, 1939, 445 patients with tumors of the bladder were seen in our Urologic Service. One hundred and seventy-eight did not receive radium treatment; the remaining 267 cases, which form the basis of this paper, received radium irradiation alone or in combination with other methods of treatment.

Microscopic examination of the tumor was made in all but 4 cases. The tumors were studied by the bladder tumor registry of the American Urological Association and graded in cooperation with our own Pathological Department. Primarily we divided our material into two groups: one including all papillary tumors and the other including non-papillary infiltrating solid carcinomas.

The papillary carcinomas were then grouped into three different grades. Grade I included all tumors of low grade malignancy with no evidence of infiltration and regular arrangement of cells. Papillary tumors with frequent mitotic figures, irregularity of cell structure and infiltration into the deeper layers of the bladder mucosa and musculature were classified as Grade III, whereas tumors with evidence of a moderate degree of malignancy or infiltration were graded as Grade II. Non-papillary solid infiltrating tumors were classified according to cell type and degree of differentiation or metaplasia. This group includes undifferentiated anaplastic tumors and differentiated tumors with various degrees of keratohyalinization and pearl cell formation, also adenocarcinoma and colloid carcinoma (see Table 1).

The size of the tumors in our 267 cases varied from a few millimeters in diameter to tumors covering large areas of the

TABLE I

PATHOLOGICAL CLASSIFICATION

Papillary Carcinoma			Non-papillary Solid Infiltrating Carcinoma				No Biopsy	Total
Grade I	Grade II	Grade III	Undifferentiated	Differentiated	Colloid	Adenocarcinoma		
51	111	39	5	54	1	2	4	267

* From the Urological Department of the New York State Institute for the Study of Malignant Diseases, Burton T. Simpson, Director. Read at the Twenty-sixth Annual Meeting, American Radium Society, Cleveland, Ohio, June 2–3, 1941.

TABLE II

SIZE OF TUMORS

Diameter	Single Tumors			Multiple Tumors (largest tumor)		
	Papillary	Non-papillary	Total	Papillary	Non-papillary	Total
Less than 1 cm.	8		8	5		5
1–2 cm.	38	1	39	19		19
2–3 cm.	37	8	45	25	2	27
3–4 cm.	23	10	33	11	2	13
4–5 cm.	10	8	18	5	2	7
Over 5 cm.	19	26	45	3	2	5
Size not recorded				2	1	3
	135	53	188	70	9	79

bladder wall. The tumors less than 1 cm. in diameter were observed only in papillary carcinomas (8 cases), whereas none of the solid infiltrating carcinomas were smaller than 1 cm. in diameter. Tumors less than 3 cm. in diameter were in the majority of cases papillary carcinomas (93.5 per cent). Only comparatively few (6.5 per cent) were solid infiltrating carcinomas (see Table II).

Single tumors on first examination were found in 188 patients (70.5 per cent). In the remaining 79 patients (29.5 per cent) two or more tumors were present. Of these 79 cases with multiple tumors, 71 were papillary while only 8 patients had non-papillary solid carcinomas (see Table III).

In recording the site of the origin of the tumor in the bladder a difference was noted between the location of the papillary and non-papillary carcinomas. (In 2 cases, the tumors were so extensive that it was impossible to determine the site of their origin.) If multiple tumor formation was present, the location of the largest tumor seen on first cystoscopy was recorded. The distribution of the tumor is graphically demonstrated in Figure 1. It was found that 139 (68.5 per cent) of 203 papillary tumors were located on the trigone and the adjacent parts of the bladder mucosa. Thirty-four (54.8 per cent) solid carcinomas originated in the lateral, posterior or anterior wall and bladder vault. A more striking difference can be noticed in tumors around the ureteral orifices, as shown in Table IV; 42.4 per cent of all papillary tumors were located in the immediate vicinity of the ureteral orifices as compared with only 16.1 per cent of the group of non-papillary infiltrating carcinoma.

TABLE III

NUMBER OF TUMORS ON ADMISSION

No of Tumors	Papillary	Non-papillary	No Biopsy	Total	Per Cent
1	130	54	4	188	70.3
2	29	3		32	10.8
3	12	1		13	6.3
4	8			8	3.0
Over 4	22	4		26	9.6
Total	201	62	4	267	100.0

Before proceeding with interstitial radium irradiation we consider the several factors just enumerated in each individual case, namely, histopathology, size, number and location of the tumor as well as other complicating factors such as severe infection, with or without the formation of incrustations or stones, severe hemorrhage, ureteral obstruction and renal infection.

As is seen in Table V, tumor areas larger than 5 cm. in diameter require excessive amounts of interstitial radiation to destroy

TABLE IV

LOCATION OF TUMORS

Site of lesion	Papillary		Non-papillary		Total
	No.	Per cent	No.	Per cent	
Ureteral orifice	86	42.4	10	16.1	96
Outer border of trigone	29	14.3	9	14.4	38
Midline trigone	16	7.9	5	8.1	21
Bladder neck	8	3.9	4	6.5	12
Posterior wall	23	11.4	12	19.4	35
Lateral wall	30	14.8	17	27.4	37
Anterior wall	7	3.4	3	4.8	10
Vault	4	1.9	2	3.3	6
Total	203	100%	62	100%	265

Two cases, locations undeterminable

the tumor. The same rule applies when many tumors are present. We therefore avoid, whenever possible, the implantation of radon when more than three tumors of 1 to 3 cm. in diameter are present.

The location of the tumor is important as we have frequently seen that lesions located in or around the internal vesical orifice have a definite tendency to develop more severe reactions even if treated most conservatively.

Aside from these considerations, the histology of the tumor is important because there exists some relationship between histology and radiosensitivity of the tumor. In general, papillary tumors are more radiosensitive than the solid infiltrating carcinomas. Except in rare instances, good results have been obtained only when solid tumors were not larger than 3 to 4 cm. in diameter.

TABLE V

MILLICURIES REQUIRED TO DELIVER VARYING DOSES WITH RADON SEEDS TO SPHERICAL MASSES

Diameter of Mass cm.	1 S.E.D. (2200 r) mc.	2 S.E.D. (4400 r) mc.	3 S.E.D. (6600 r) mc.	4 S.E.D. (8800 r) mc.
1.0	0.54	1.08	1.62	2.16
1.5	1.23	2.46	3.69	4.92
2.0	2.1	4.2	6.3	8.4
3.0	4.7	9.4	14.1	18.8
4.0	8.4	16.8	25.2	33.6
5.0	12.2	24.4	36.6	48.8
6.0	19.0	38.0	57.0	76.0

1 S.E.D. equals 2200 r for seeds filtered through 0.3 mm. platinum.

Compiled by Reinhard and Goltz.

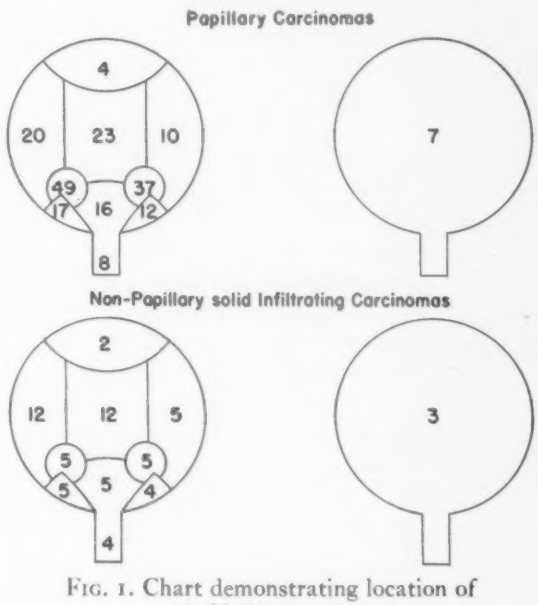

FIG. 1. Chart demonstrating location of 265 bladder tumors.

Only 52 of our cases, when first seen, were considered suitable for immediate interstitial irradiation. In the remaining 215 cases, it was considered advisable to employ preliminary treatments in the hope of making them more amenable to radon irradiation.

Roentgen therapy proved to be of particular value in many cases of multiple or extensive papillary tumors; a marked decrease in the number and size was obtained. (Complete regression of the tumor was accomplished only in rare instances.) On the other hand, the response to roentgen treatment (200 kv.) in the group of non-papillary solid carcinomas was generally poor. The roentgen treatment given consisted of 200 kv. radiation, half-value layer 0.9 mm. copper, 80 cm. target-skin distance, using multiple fields. The daily dose applied varied from 150 to 400 r (measured with backscatter) per field to the limit of skin tolerance. The depth dose delivered to the tumor averaged 2,600 r, using two fields, 3,400 r using one anterior and two posterior fields and 4,300 r if two anterior and two posterior fields were employed.

Electrocoagulation, either with the point electrode or loop resector, was also of value in preliminary treatment in cases of papillary carcinoma. By this means, the bulk of the tumor was removed in many cases, leaving a relatively small tumor base exposed for more accurate radon implantation.

After the full benefit of roentgen therapy or electrocoagulation, or both, had been achieved, usually six to eight weeks later, radon implantation was carried out.

In the majority of cases, implantation of seeds through the cystoscope was preferred to suprapubic approach. Indications for suprapubic implantation was limited to cases in which the location and size of the tumor did not permit accurate seeding through the cystoscope. Tumors partially or completely covered by incrustations and cases in which uncontrollable bleeding occurred were treated by suprapubic cystotomy. Suprapubic approach was avoided if possible in papillary tumors because they are well known to have a tendency to serial reappearances.

In determining the amount of interstitial radiation to be delivered to the tumor, Table v is of value. This table serves as a guide in planning how many millicurie-hours will be required to deliver a predetermined dose to a tumor of a certain size.

However, it has proved impossible during the actual implantation of radon implants to follow these rules rigidly. Technical difficulties during the application of seeds through the cystoscope such as bleeding, small bladder capacity or unfavorable location of the lesion, etc., make it necessary for the urologist to rely somewhat more on clinical experience than on the data determined under experimental conditions.

In the employment of radon implants, we have endeavored to place them equidistantly in such a manner that each cubic centimeter of tumor area receives a radiation energy of one implant. We have in the past repeatedly employed seed implants of the strength of 2 mc., but in more recent years have favored the use of seeds from 1.0 to 1.5 mc. (3 mm. in length and 0.3 mm. gold filter).

In a limited number of female patients, radium element radiation was used. These were cases of solid infiltrating tumors which involved the floor of the bladder, the induration of which could be felt through the anterior vaginal wall. Three to five 0.6 mm. platinum filtered needles, each containing three cells of 1 mg. radium element each were placed through the anterior vaginal wall into the base of the tumor and left in place for five to seven days. The total dose delivered varied from 2,000 to 3,500 mg-hr. This procedure was employed in 15 cases of large infiltrating carcinoma and 3 of this group are alive and well, 2 of them for more than five years.

Immediate reactions most frequently encountered after interstitial radium irradiation were ulcerations. Late radium reactions commonly observed were telangiectases and rarely scar formation causing obstructive symptoms of the upper urinary tract, if the scarring involved the region of the ureteral orifice.

Development of ulcerations at the site of radon implants is by far the most common reaction. Such ulcerations occurred in 197 (73.7 per cent) of the 267 cases treated. No

Fig. 2. *A*, five radium element needles placed in solid infiltrating carcinoma at the base of the bladder through the anterior vaginal wall. *B*, cystogram of the same case after implantation of radium needles.

evidence of ulceration was seen in 26 (9.7 per cent) cases. In 44 cases (16.6 per cent) the development of an ulceration could not be definitely ascertained. The latter group is comprised of patients who either were not re-examined after implantation of radon, those who died shortly after operation, or those patients in whom it was impossible to determine whether an ulcerating tumor or a radium reaction was present.

Of the 197 cases in which ulceration was observed, healing took place in 106 instances, whereas in the remaining 91 cases, the ulceration persisted. Healing of radium ulceration took less than one year in the majority of cases. Of the 106 cases in which the ulceration disappeared, 78 healed within the first year, 21 healed within the second year and 2 healed within two and a half years after the treatment. In 5 instances the duration of the ulceration was not recorded in the case histories.

The size, duration and clinical course of acute radium reactions depend on several factors. The histopathology of the tumor is of importance because tendency to ulcer formation was least in the carcinomas of low grade malignancy and greatest in the group of solid infiltrating tumors. Of 55 grade 1 papillary tumors treated, no ulceration was observed in 15 cases. In 34 cases, healing took place and in the remaining 6 cases, evidence of ulceration was still present at the last examination. On the other hand, of 45 patients with solid infiltrating carcinoma, no ulcer was seen in only 2 cases, healing of the ulceration was observed in 18 cases, and in 35 cases the ulcer persisted.

Obviously, the size, duration and clinical course of radium ulcerations are in direct proportion to the size of the area treated and to the amount of radiation delivered. Our statistics show that, regardless of the histopathology of the tumor, reactions from radon implants present a more favor-

Table VI

NUMBER OF MILLIGRAM-HOURS REQUIRED TO DELIVER A DOSE OF 2000 r AT A DISTANCE OF 0.5 CM. BY NEEDLES OF 0.6 MM. Pt FILTER

Needles	3–3 cell		4–3 cell		5–3 cell	
Area	6.6 sq. cm.		9.9 sq. cm		13.2 sq. cm.	
mg-hr.	347		444		540	
Distance cm.	A ↕ per cent	B → per cent	A ↕ per cent	B → per cent	A ↕ per cent	B → per cent
0.5	100.0	83.5	100.0	80.9	100.0	81.0
1.0	52.4	34.8	56.6	36.8	61.0	38.6
1.5	31.7	19.3	36.1	21.3	40.0	23.2
2.0	21.3	13.4	22.5	15.1	27.8	16.8
2.5	14.8	9.5	17.6	10.8	20.0	12.1
3.0	10.8	7.2	13.0	8.3	15.1	9.3
4.0	6.7	4.6	8.2	5.3	9.7	6.1
5.0	4.5	3.2	5.5	3.8	6.6	4.4

A—relative intensity under center of area.
B—relative intensity lateral to end needle.
Compiled by Reinhard and Goltz.

able course if the area treated did not exceed 1 cm. in diameter. Of 22 cases with lesions treated smaller than 1 cm. in diameter, ulcer formation was not observed in 10 cases, and in 12 cases the ulcer healed within three to nine months. However, if tumor areas larger than 4 cm. in diameter were treated with radon implants, no ulceration was seen in only 5 instances, in 18 cases healing took place and in 42 cases the ulceration persisted.

TABLE VII

END-RESULTS

	No. of Cases	Per Cent
Died of disease	129	48.31
Died other causes	17	6.37
Lost trace of	14	5.25
Alive and well	97	36.32
Alive with disease	10	3.75
Total	267	100.0

As to the number of millicuries delivered to the tumor, we found that of 134 patients who received less than 3,000 mc-hr. persistent ulcerations developed in 34 cases, whereas in the remaining 100 patients disappearance of the ulcer was observed. The course of the ulcerations was less favorable in the treatment of 80 tumors to which more than 3,000 mc-hr. was given. Only 27 of the ulcerations formed healed, and in the remaining 53 patients the ulceration persisted.

The results accomplished in our series of 267 cases are pointed out in Table VII.

The total number of living patients in whom the bladder is free of tumor is 97 (36.3 per cent) of 267 cases. Thirty-five of these have been well for more than five years. Since 119 patients were treated during the period from 1930 to 1934, the percentage of five year cures amounts to 28.6. Twenty-eight patients with five year cures had papillary carcinoma and 7 had non-papillary tumors. This makes a total of 33.3 per cent cures for the papillary and 21.9 per cent for the non-papillary carcinomas. The three year cures of 67 cases treated during the first two years of the second five year period showed 31 cases (46.3 per cent). This group of 67 cases was comprised of 21 papillary and 16 non-papillary carcinomas. Of the papillary carcinomas, 27 (52.9 per cent) were free of tumor for more than three years and of the non-papillary carcinomas, 4 (25 per cent) were free of tumor for more than three years (see Table VIII).

The results accomplished in the total number of cases which are well are as follows:

Papillary carcinoma
- Grade I 28, or 74.5% of 51 cases
- Grade II 40, or 36.0% of 111 cases
- Grade III 7, or 17.9% of 39 cases

Non-papillary solid carcinoma
12, or 19.3% of 62 cases

TABLE VIII

ALIVE AND WELL

	Single				Multiple				
	Papillary carcinoma			Non-papillary solid carcinoma	Papillary carcinoma			Non-papillary solid carcinoma	Total
	I	II	III		I	II	III		
1st yr.		2	1	1		1			5
1–2 yr.	5	3	1		3				12
2–3 yr.	6	5	1			2			14
3–4 yr.	5	2	1		3	2			13
4–5 yr.	7	3		3	2	2		1	18
Over 5 yr.	7	13	2	7		5	1		35
Total	30	28	6	11	8	12	1	1	97

CONCLUSIONS

Results of 267 cases of bladder tumor treated with radium irradiation are presented. These cases consist of a group treated between January 1, 1930, and December 31, 1939, which at that time were considered suitable for radium therapy.

Our indications for the use of radium in the treatment of bladder tumors have undergone considerable change during the past ten years and we would emphasize that we would treat many cases included in this report differently at the present time.

We believe that papillary carcinomas of low grade malignancy, whether single or multiple, do not usually require interstitial radium therapy. They are best treated by roentgen irradiation and electrocoagulation either alone or in combination. Excluded from radium irradiation also should be all cases with lesions which are far advanced. The amount of radium required for the destruction of very extensive tumors is so great that severe radium necrosis results. In tumors of this type some palliative results may be obtained by roentgen irradiation, electrocoagulation or surgical procedures such as subcutaneous ureterostomy, nephrostomy, total cystectomy, etc.

In the treatment of infiltrating papillary carcinomas and non-papillary solid tumors, radium is useful if the lesion is less than 5 cm. in diameter. Papillary tumors may be decreased in size by preliminary roentgen therapy or electrocoagulation. Solid non-papillary carcinomas which are usually radioresistant and do not respond to roentgen irradiation will, in some instances, respond favorably to interstitial radium irradiation.*

* For discussion see page 922.

CANCER OF THE RECTUM AND SIGMOID

WITH SPECIAL REFERENCE TO THE DISEASE AS SEEN IN OLD AGE*

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PENNINGTON,[15] in a collection of 7,313 cases of cancer of the rectum and sigmoid, found that in 13 per cent the patients were seventy years of age or older. It is thus evident that the treatment of this disease in old age is not an uncommon problem. It is a difficult problem, for there are many complications debilitating these old people, including degenerative processes, particularly cardiorenal disease. However, prostatic hypertrophy, curiously enough, is rarely encountered to a degree necessitating surgery. In a series of 116 cases of cancer of the rectum and sigmoid in males, personally treated, prostatectomy was required in only one instance.

The control of this type of cancer in old age involves a nice correlation of all available factors, perhaps the most important being a correct appraisal of the ability of the patient to withstand the effects of surgical or other therapeutic attack, for it is of interest that with proper selection these aged patients will withstand surgical procedures well.

The present paper is a review of 166 consecutive cases of cancer of the rectum and sigmoid which have been under my care. From this series I have chosen for particular study 19 individuals aged seventy years or more, comprising 17 per cent of the whole. Many surgeons in the past have set sixty-five as the age limit for surgical procedures, but it is evident that merely a tabulation of age does not give the entire picture. Many a man at seventy is a better risk than a man ten years his junior, and it is obvious that the prolonged terminal suffering of a man in his seventh decade is at least equal to the pain and discomfort of those younger.

Some months ago I was asked to operate upon a woman of seventy-seven who had a slight obstruction caused by cancer of the rectosigmoid. Her heart was fibrillating but her blood pressure was not high, she was wiry, and above all, she wanted very much to live. A combined abdominal perineal operation was performed, following a preliminary transverse colostomy. She made an uneventful recovery and was out of bed in nine days after the operation.

CRITERIA OF OPERABILITY

The presence of regional metastases is of course important, though their presence or absence closely parallels the grade of tumor as classified by Broders and though the prognosis is undoubtedly influenced by the extent of the disease as estimated by Gabriel, Dukes and Bussey;[9] yet neither of these items should be used as a final guide to therapeutic effort. Furthermore both the eye and the finger make mistakes. The gross estimation as to the extent of malignancy in lymph nodes, even when palpated within the abdomen, is notoriously inaccurate. Gabriel, Dukes and Bussey,[9] for instance, have noted that of 337 nodes of which the appearance was judged to indicate malignant involvement on the basis of gross characteristics, metastasis was present in only 132—an error of 205, or 61 per cent.

Brown and Warren[4] found lymph node involvement a disappointment as an indicator in the prognosis of this disease, and they stress the importance of the invasion of blood vessels, though only a small proportion of tumor cells entering the blood stream become manifest as visceral metastasis.

The dictum of Gilchrist and David[10] that the size of the tumor is of little value in determining the presence or absence of metastasis to lymph nodes is borne out in our cases. Within a week I operated upon 2 individuals with cancer of the rectum. The

* Read at the Twenty-sixth Annual Meeting, American Radium Society, Cleveland, Ohio, June 2–3, 1941.

first had a tumor only 2 cm. in diameter and with metastases to eight out of ten nodes, while the second had a neoplasm 12 cm. in diameter but with no metastases in the nine nodes examined.

The situation of the tumor is of extreme importance in these old people, for the low growth, allowing the surgeon to perhaps do a colostomy and posterior excision after the technique of Lockhart-Mummery, carries with it usually definitely less risk than the high lying cancer which would necessitate for cure some form of abdominoperineal resection. However, inasmuch as but 30 per cent of cancers of the rectum and sigmoid are in the rectum proper with about 2 per cent in the anal canal, somewhat less than one-third of the cases will be suitable for a thorough Lockhart-Mummery procedure.

Lesions situated on the anterior wall, particularly those perforating, usually have a poorer outlook than similar lesions on the posterior wall, even though the latter may be firmly fixed. Again, lesions situated on the mesenteric border are found to have a worse prognosis than those on the antimesenteric border. In the case of the growth operable except for liver metastasis, resection of the bowel is, of course, justified. I have had several such patients live for many months in comfort. C. W. Mayo[14] reports instances in which patients thus afflicted lived for five years or more.

A most serious factor in the aged is intestinal obstruction, for a rapid change in the body chemistry takes place, and the effects may even persist after the obstruction has been relieved.

Marked obesity is a positive contraindication to radical surgery in those past the seventh decade. A more conservative procedure with a lower mortality (but also usually with a poorer prognosis) must be chosen.

Loss of weight and anemia do not necessarily preclude radical therapy, for the gastrointestinal disturbance and the worry caused by the persistent symptoms can cause a considerable loss of weight, which is regained after operation, often even after a simple colostomy, and the anemia is usually well handled by one or more transfusions. We would agree, however, with the statement of Jones[12] that in the absence of obstruction a simple colostomy gives little relief either from the pain of metastasis or the tenesmus of an ulcerating neoplasm.

Associated chronic diseases do not necessarily contraindicate a complete surgical attack. The majority of these aged people, of course, have cardiorenal disease in varying degrees. Severe diabetes can be controlled, though a high carbohydrate diet is given, and the growth successfully resected. Fixation is considered by many as an important criterion of operability, but may we stress the plea that these patients be examined in various positions before drawing hasty conclusions and that fixation as felt per rectum is not necessarily a contraindication.

DIAGNOSIS

An increase in life expectancy in the population brings with it an increase in cancer of the rectum and sigmoid. Daniel,[7] in a recent paper, reports that now in the United States 35,000 lives are taken by this disease annually. Binkley[3] stated a year ago that he believed the incidence of cancer of the rectum is definitely on the increase.

But diagnosis has not kept pace with therapeutic management and therefore it is indeed fortunate that cancer of the large bowel is of slow development. Although approximately 90 per cent of the cases of cancer of the rectum are detected on a digital examination, yet unfortunately two-thirds of these are far advanced when first discovered. We have no statistics revealing the accuracy of digital examination in the early case, but it is a depressing fact that in any large series only 10 per cent can be classified as falling into Dukes' group A (i.e. limited to the mucosa, submucosa and muscularis) and it is in just this group that a more than 75 per cent five year curability rate can be expected. Early symptoms and

signs are so slight that not a few physicians have failed to recognize symptoms of rectal cancer *in their own person* until it had become advanced, more than one such individual having sought advice for what he called gas or a mild indigestion.

I have personally operated upon 5 cases of cancer of the rectum that had preoperatively no symptoms suggesting rectal disease. All these were discovered in the course of a routine physical examination.

It is, of course, futile to expect a high percentage of cures without employing a radical procedure, for Gilchrist and David in a carefully studied series have demonstrated regional node metastases in 68 per cent of the cases.

THERAPY

It is fairly generally agreed that the abdominoperineal resection offers the greatest hope of cure in cancer of the rectum. Next in order would come colostomy and posterior resection. Here, though the mortality is usually somewhat lower, yet the final cure figure is also lower. For the sigmoid we have available the Mikulicz and the end-to-end type of resection, the latter preferably preceded by transverse colostomy. It is the growth at the rectosigmoid level that has recently stimulated a violent controversy in regard to therapy. In my opinion, the growth at this level should be treated by abdominoperineal resection if it is in any way possible; for anterior resection, end-to-end resection in the pelvis, abdominosacral or perineal resection employing the "perineal" Mikulicz technique all have this in common: they all retain the rectal stump—and it is in or near this stump that there is a definite, though infrequent tendency to metastasize even though the resection has been extensive. I have seen recurrence in 2 such cases and have noted many others in the literature.

Carter, Slattery and Hahn[5] urge the more frequent employment of the "sacral Mikulicz" procedure combined with an abdominoperineal approach. Küttner[13] in 1910 first applied the Mikulicz principle for reestablishment of the continuity of the rectum with conservation of the sphincters. In 1924 he reported more than a hundred cases with 24 per cent five year cures. However, about 25 per cent of his series had poor control of their rectal sphincters and approximately another 20 per cent had only fair control. Carter reports 8 cases operated upon by this method, of which 3 developed strictures, 2 others had persistent perineal fistulae after six months, and a sixth died of peritonitis. In one case there was sloughing of the proximal sigmoid.

It has been our experience that when the superior hemorrhoidal artery has been sectioned and an adequate freeing of rectum and sigmoid has been performed, and when there has been a radical removal of areas of potential recurrence, the blood supply of the distal bowel is frequently jeopardized and thus is poor material for further surgery even by the Mikulicz technique. Even should sloughing not occur (and this misfortune has occurred more than once to my knowledge), yet stricture is the rule. I have seen a subsequent abdominal colostomy necessitated. Thus, the disadvantages of this technique seem to outweigh the advantages. Only one case in Carter's series has lived without disease more than five years, so obviously there can be no comparison with other techniques as regards end-results.

Arnold and Shea[1] report 5 cases thus operated upon. One lived four years without recurrence. There were two deaths, one from peritonitis. Stricture is not mentioned nor is the question of persistent fistula.

These two papers will, I fear, cause the employment of the "sacral Mikulicz" in an unjustifiably large number of cases inasmuch as at least 50 per cent of the cases of cancer of the rectum and sigmoid occur at the junction of these two divisions. At this level resection of the rectum followed by end-to-end suture is to be considered only to be rejected, for if the area of resection is at or near the pelvic peritoneal reflection there is again the danger of metastasis below the area of resection. Furthermore,

an end-to-end suture below the level of the peritoneal reflection almost invariably results in a stricture at the suture line. Gorelik and Horowitz[11] report one case thus operated upon. The individual is alive and apparently well thirty-three months after operation. Gorelik quoted Horsley's report of 3 cases so treated. However, though Horsley utilized a preliminary cecostomy, 2 of the 3 cases died.

With the growth at or near the peritoneal reflection, if the patient refuses operation unless promised an eventual re-establishment of intestinal continuity, I offer the following plan: Perform a generous anterior resection and then carefully observe the rectal stump for at least three years, being ready to resect it if there is any suggestion of neoplasm involving it or its proximity. Then, at the end of three or more years, an anastomosis may be done. The following is an illustrative case history:

In 1937 Mrs. A. C., aged thirty-four, had noticed rectal bleeding and increasing constipation for about four months. Occasional stabbing right lower quadrant pain had been observed for about two months. Digital examination was negative, but sigmoidoscopy revealed a productive granular neoplasm. Biopsy showed adenocarcinoma Grade 2. An anterior resection was performed leaving a rectal stump of 6 to 8 cm. The pathological examination of the resected bowel showed a growth 10 cm. long and with regional metastases.

In April, 1941, I performed a right transverse Mikulicz, cutting off the fecal stream from the distal bowel. Three weeks later, the sigmoid was freed and a large caliber rubber tube inserted into it and sutured to it. The distal end of this tube was then inserted into the rectal stump and pulled down, invaginating the sigmoid into the rectum. The sigmoid was tacked in place with a few loose silk sutures and the pelvis was drained. Two and one-half weeks later the Mikulicz was closed. The patient made an uneventful recovery.

It is our belief that the procedure offering the greatest chances of successful outcome and with a moderate operative risk in the old person is the following two stage operation: (*a*) a right transverse colostomy of the Mikulicz type, followed in three or more weeks by (*b*) a Miles abdominoperineal resection. The mobility of the proximal half of the transverse colon and preservation of the function of the cecum and hepatic flexure make it a good colostomy site. Then, too, the wound is farthest removed from that of the secondary operation of any of the colostomies. With this technique there is no hurry to complete the second stage as with the Daniel Jones procedure; the surgeon does not enter the same operative field twice as with the techinque of Lahey, and finally, there is an opportunity for a more complete removal of potentially dangerous nodes than with the technique of Lockhart-Mummery. During the interval between stages the bowel distal to the colostomy can be thoroughly cleaned of fecal material and a glycogen reserve built up in the liver, and, what is more important, the vitamin, mineral, fluid and electrolyte balance can be adjusted and maintained. Several transfusions can be given if necessary. Coller,[6] and others, have well shown the disturbances caused by the deprivation of blood, water, salt or glucose. Not infrequently these old people have a marked deficiency in plasma proteins. All these abnormal conditions must be corrected by the surgeon both before and after the therapeutic procedure.

It is obvious that the water intake of the patient must equal his output, not only that lost by the excretion of waste products but also that eliminated by vaporization and by respiration. A study of this problem is vital in the aged for they can as easily become overloaded with fluid as they can become dehydrated.

If the cardiorenal apparatus is equal to the task, we try to have the patient maintain a constant output of 35 ounces, guarding carefully against a low serum protein. For in this condition there may be excessive salt administration with the resultant edema. A urinary output with a specific gravity of 1.015 or less usually indicates a satisfactory intake.

It is thus clear that we urge prolonged

TABLE I

CARCINOMA OF THE RECTUM—166 CASES

Cases 1 to 83		
83 cases 12 deaths in hospital	Mortality	14.4%
83 cases 53 resections	Operability	63.8%
53 resections 10 deaths in hospital	Resection mortality	18.8%
Cases 84 to 166 (83 cases)		
83 cases 4 deaths in hospital	Mortality	4.8%
83 cases 67 resections	Operability	80.7%
67 resections 3 deaths in hospital	Resection mortality	4.4%

and careful preparation before resection is undertaken. With the one-stage procedure we delay for at least a week and with the two-stage operation we insist on an interval of at least three weeks. These resections are never emergency procedures. As Jones[12] puts it "the eager surgeon should be handcuffed."

If resection is out of the question, our next choice is electrocoagulation plus irradiation, for the combination of these two gives results superior to either alone. One may employ a course of high voltage roentgen therapy followed by primary or fractional electrocoagulation, he may employ high voltage roentgen irradiation plus fractional radium treatment with the Binkley applicator[15] plus fractional electrocoagulation, or he may substitute the implantation of radium seeds for the Binkley applicator. The method that holds the most promise is fractional electrocoagulation, which should soon stop bleeding and relieve a great deal of the tenesmus, followed by a course of radium treatment.

Fractional electrocoagulation (i.e. the frequent employment of light doses of electrocoagulation, searing the tumor but not too deeply) deserves more attention than it has thus far received. With this technique there is only slight danger of later hemorrhage, but it presupposes a tumor that can be fairly easily approached and a patient who is tolerant of frequent mild dilatation of the anal sphincter.

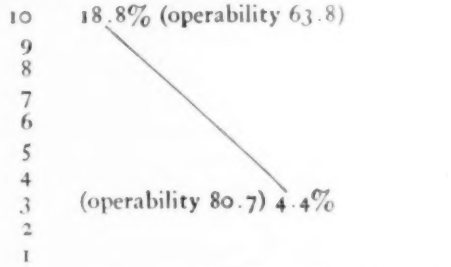
High voltage and even supervoltage radiation, in our experience, have been disappointing. However, the fact that the occasional case does respond well has prevented this method from being entirely abandoned, particularly as an adjuvant in the case of a growth springing from the hollow of the sacrum.

Strauss, *et al.*[16] in 1935 reported the use of surgical diathermy for the removal of malignant tumors of the rectum. Of the 42 patients so treated, 2 died in the hospital and 10 lived for five years or more. Strauss and his coworkers urged the fractional method of treatment as militating against stricture, hemorrhage and sepsis. In 1937 Santos reported 35 cases treated thus, of whom 14 lived for five years or more.

It is, however, my belief that electrocoagulation should be considered as a pal-

TABLE II

OPERATIVE MORTALITY IN 120 RESECTIONS FOR CANCER OF THE RECTUM AND SIGMOID (ALL AGES)



The total number of cases (166) was divided into two consecutive series of 83 cases each. In the first group there were 53 resections (an operability rate of 63.8 per cent) and 10 deaths (a mortality of 18.8 per cent).

In the second group there were 67 resections (an operability of 80.7 per cent) and 3 deaths (a mortality of 4.4 per cent). This improvement, we believe, is due to more careful selection of therapeutic technique and of more thorough preoperative preparation of the patient.

liative treatment to be occasionally employed as a curative therapy only in the treatment of locally operable cancer in the bad surgical risk. In electrocoagulation of the low growth the Pratt bivalve speculum is useful and I am favorably impressed with a suction electrode devised by Ferguson.[8] It is my custom to cook the surface until the tissue changes to a whitish-yellow which may then be removed with a curet.

It is following recovery from the electrocoagulation that intracavitary irradiation with the Binkley applicator is best given, for the coagulation markedly reduces the size of the tumor and leaves a healthier base for irradiation. Furthermore, by electrocoagulation the lumen may be so increased in diameter in the case of annular growth that the insertion of the Binkley applicator is facilitated. I have not as yet treated enough cases to venture an opinion as to optimum dosage by radium thus applied or as to the correct time interval between the electrocoagulation and irradiation. Binkley employs a total dose of 3,000 to 6,000 mc-hr. Of 20 patients so treated there were 12 alive and well from one to three years (2 had reinforcement with gold seeds).

The employment of the Binkley applicator presupposes the daily availability of 100–200 mg. of radium for from two to four weeks. This would make the method impractical except in institutions with large amounts of the element. We like the Binkley applicator and are impressed with the early improvement and the slight temporary discomfort entailed by its use.

Binkley in 1940 reported 31 patients treated by irradiation prior to 1938, the treatment consisting of roentgen therapy plus implantation of seeds. Of this group 24 were alive and well for over three years and 9 had survived periods of from five to ten years. This is an excellent result following irradiation—the best I can find. But there is no question that the after-effects of radium implantation in the rectum are definitely disagreeable. Many clinics have

TABLE III

19 CASES OF CANCER OF THE RECTUM AND SIGMOID IN THE AGED (I.E. BETWEEN 70 AND 81)

Duration of Symptoms before Admission

	Cases
From 1 to 2 months	2
From 3 to 4 months	4
From 5 to 6 months	1
From 7 to 12 months	7
Over 12 months	5
	19

Outstanding Urologic Symptom on Admission

	Cases
Dysuria	3
Frequency	4
Nocturia	9
Difficulty starting	1
Urgency	1
No symptoms	1
	19

TABLE IV

SUMMARY OF THE GROUP OF 19 AGED PEOPLE TREATED BY VARIOUS METHODS

(a) 1 case—One-stage "Miles" resection—Five year cure
(b) 1 case—Colostomy plus postexcision—(after one year) dead of disease
(c) 5 cases—Two-stage resection (Daniel Jones)technique
  1 seven year cure
  1 five year cure
  2 dead (disease) after two years
  1 operative death
(d) 2 cases—Miles resection preceded by transverse colostomy
  1 well three years
  1 dead heart disease one month after leaving hospital
(e) 5 cases—Colostomy and irradiation
  1 alive six months without disease
  4 dead with disease
(f) 5 cases—*Electrocoagulation plus irradiation*
  1 five year cure
  1 dead after three years without disease
  3 well six months

Of the 19 aged people treated:
  4 are well without disease over five years
  2 are well without disease over three years
  1 operative death

abandoned this technique and in others a few seeds are timidly inserted for "palliation." On the other hand, convalescence from high frequency electrocoagulation is not particularly disturbing and, in fact, immediately relieves symptoms in many instances. It is for these reasons, in my opinion, that we are going to see our best palliative (and occasionally curative) results from electrocoagulation followed by intracavitary irradiation by the Binkley applicator.

SUMMARY AND CONCLUSIONS

1. Radical therapy (resection) can be employed in a high percentage of cases of cancer of the rectum and sigmoid (80.7 per cent in this comparative series).

2. If a graded procedure must be employed, a right transverse colostomy is the most satisfactory first stage.

3. The mortality with radical therapy (resection) can be reduced to a low figure (4.4 per cent in this comparative series) if the patient and therapy are adequately appraised.

4. Fractional electrocoagulation plus fractional intracavitary radium irradiation is perhaps the best alternative to radical therapy. Implantation of radium seeds may be substituted for the intracavity radium irradiation.

5. Aged individuals with this disease can be treated effectively if there is proper choice of therapeutic technique.

6. A much higher percentage of cures will be attained by any of these methods if cancer is sought out *before* it causes symptoms.

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DISCUSSION ON PAPERS OF DRS. HERGER AND SAUER, AND SHEDDEN

DR. GEORGE S. SHARP, Pasadena, Calif. Dr. Herger kindly forwarded his manuscript, and after reading it I certainly was impressed with the amount of material he had and the way it was handled. We all agree with him that the non-invasive cancer of the bladder may be treated by fulguration alone or in conjunction with postoperative high voltage roentgen therapy. Decision on roentgen therapy might depend upon the microscopic sections and whether there was evidence microscopically of invasion. On the other hand, the invasive, crater-like growth certainly is frequently a definite lethal and malignant condition and the opinions are not entirely uniform. Fulguration and high

voltage roentgen therapy are important for this group, also, but they naturally are not as effective.

There is no evidence to show that fulguration causes a dissemination of cancer, and the reasons for giving it, it seems to me, are first, it removes the bulky portion of the growth; second, it causes a shrinkage in size of the growth; and third, it increases the blood supply in the base.

High voltage roentgen therapy being given as a preliminary measure, of course, has obviously a specific effect on the cancer cell itself and by the delivering of 3 to 4 erythema doses into a bladder tumor, these irradiation effects are readily demonstrated microscopically.

The chief reliance for the cure or attempted cure in these invasive and crater-like growths in the bladder rests on interstitial irradiation. There are several ways of giving the preliminary treatment, however, which should be mentioned.

First, contact therapy, as can be done with the Philips tube or it can be done by the application of a radium plaque directly on the growth within the bladder. Both of these methods lend accuracy as well as an adequate measured dose to the growth.

I think so much depends upon the implantation of radon seeds, which after all is the primary curative measure. This implantation, if it is going to be done in a single treatment, should be performed always by a suprapubic route. It does mean a little hospitalization but heavy doses of radon seeds in the bladder cannot be repeated without causing serious post-irradiation changes.

I don't use a cystoscope but in our experience with urologists and in our treatment of many cancers of the rectum, we find it quite difficult to even implant uniformly a cancer of the rectum through a 1 inch proctoscope (1 inch in diameter) and feel that we have done it accurately and not overdosed certain areas and underdosed others.

It might be suggested that, if the cystoscopic implantations are continued, a method much as we are using now be employed, namely, first of all giving the heavy preoperative high voltage roentgen cycle and then implanting the cancer of the bladder uniformly with a much smaller dose with the possibility of repeating the implantation. In other words, possibly only giving 2 erythema doses and using seeds from 0.5 to 0.8 mc. each, then three weeks later repeating this process to questionable areas.

We find that the treatment of cancer of the rectum in this manner has diminished the total amount of radiation that has been necessary and that the post-irradiation ulcers are not as troublesome. By this direct exposure, certainly the tumors are not overdosed.

Dr. Herger said something about there being about two-thirds to nearly three-quarters per cent of post-irradiation ulcerations, many of these taking from one to two years to heal. I would like to ask how those patients are carried along during that interval and what direct attempt is being made toward curing the ulcer as well as relieving the pain.

I did not have a chance to read Dr. Shedden's manuscript on cancer of the bowel in the aged. Certainly the patient calling at the office with definite obstructive symptoms requires fairly prompt and immediate surgery, but for those without such symptoms, haste is not required and I feel that preoperative irradiation is desirable and many times the only treatment that is required for many patients in this group.

In other words, this irradiation can easily be given in three weeks; it accomplishes the same results, that is, its effect on the inflammation in and around the tumor, and more effectively than doing a colostomy if there is no obstruction. I recall many cases of cancer of the rectum that were fairly fixed to the sacrum but after a roentgen cycle they were entirely freely movable.

Second, the effect on the tumor itself. After all there is a selective action on these tumors although less so than in other parts of the body. This is demonstrated by the fact that the tumors regress in size and by their microscopic appearance after heavy irradiation.

Third, the effect on the tumor cells diminishes the likelihood of dissemination during surgery.

In cancer of the sigmoid without obstructive symptoms it seems to me that preoperative irradiation offers a very definite place in its treatment. I recall instances of palpable growths as large as 10 cm. in diameter that regressed to 3 and 4 cm. in diameter, and surgery was facilitated in a safer manner.

Dr. Hans R. Sauer, Buffalo N. Y.: Dr. Sharp mentioned the question of radium ulcera-

tion and how to treat it. I want to stress that the percentage of cases in which radium ulcerations were observed was much higher from 1930 to 1935 at the time when radon implants from 1.6 to 2.0 mc. were frequently used. During the last five year period, radon implants of lesser strength have been used and the ulcerations observed have been less extensive and less severe.

The treatment of these ulcers depends upon the form in which they occur. Urinary antiseptics are administered, the sulfonamide group being the most efficacious particularly sulfathiazol combined with pyridium. In 47 instances incrustations and stone formation were observed which were removed with the cystoscopic rongeur.

The duration of the ulcerations is much shorter since we have employed irradiation more conservatively. Since we do not implant large areas of the tumor, the ulcerations are smaller and they usually heal within three to nine months whereas some of the ulcerations which resulted from overtreatment in earlier years did not heal at all or only after one to two and a half years.

DR. GEORGE E. BINKLEY, New York. We all agree with Dr. Shedden that rectal cancer is one of the important phases of the general cancer problem and that the status of early diagnosis is lagging behind the status of treatment.

Elderly patients present a somewhat different problem from those of less mature age, in that a higher percentage of old people are poor surgical risks, and a radical operation is more likely to be followed by shock, cardiovascular accidents, pneumonia, etc. We have apparently had more trouble from enlarged prostates in elderly males than Dr. Shedden. Because of this fact, during the past few years a number of patients have been relieved of prostatic obstruction prior to rectal resection.

In dealing with elderly people, selective treatment seems preferable to any one routine method. I have had no experience with Dr. Shedden's operation: a preliminary transverse colostomy and abdominoperineal resection. In good surgical risks we prefer the Miles type of operation. In a medium or poor surgical risk, with a large infected tumor at the upper rectum or rectosigmoidal junction, a two-stage Lahey procedure is done.

Patients with tumors located in the middle and lower third of the rectum, which are classified as medium or poor risks, are often operated upon by a preliminary colostomy and a perineal resection, and occasionally by a perineal resection without colostomy. The grade of malignancy of rectal cancer found in old people is usually less than that found in younger patients. Therefore, this less radical method is more ideal for the aged.

When surgical treatment is decided upon, one cannot overestimate the importance of preoperative preparation. The patient should be in the hospital from five days to a week or longer, during which time the colon should be thoroughly cleansed and the general condition improved by the liberal administration of food and vitamins. Ability to withstand operation may be estimated by a careful physical examination and detailed laboratory investigation, including serum-protein and vitamin levels. Operation should be delayed until the patient is in good physical condition. A patient who is in good physical condition will usually withstand the operation and have few complications.

We employ radiation therapy as a selective method in the treatment of early rectal cancer and have found it very satisfactory in many elderly patients. Radiation therapy is used routinely in all cases with inoperable disease.

The results of electrocoagulation or fulguration, in our experience, have not been uniform. A few cases have done well, but the majority have not shown as much improvement as when treated with radiation therapy, nor have our results with fulguration and radium applications been satisfactory. In the majority of instances we prefer treating the patients either by irradiation alone or by surgery alone. Radical surgery may be preceded by a small dosage of preoperative roentgen irradiation to clear up the infection.

DR. HERGER (closing). Dr. Sharp brought up one question: the matter of suprapubic approach. We do not hesitate to use the suprapubic approach when we think it indicated. We do feel that papillary cancer is radiosensitive or a better term, used by Dr. Shields Warren, it is radioresponsive. A tumor dose of 3,500 to 4,500 r can be delivered without doing excessive damage to the tumor bed. In many cases, large and multiple papillary carcinomas can thus be rendered suitable for treatment transurethrally. If after such a course they are not rendered suit-

able for transurethral treatment, then the suprapubic approach is employed.

Dr. Shedden (closing). Dr. Sharp mentioned the difficulty in implanting radium through the small caliber of a proctoscope and we agree most enthusiastically with that; that is one of the reasons why we have adopted preliminary electrocoagulation. We found that some of these tumors will shrink amazingly and become easily implanted or treated with radium in other ways after they have been electrocoagulated.

He also mentioned repeat doses with radium seeds. We have used repeat doses but have not been so happy about discomfort. We have found again that we have used less secondary dosage with radium since we have adopted the technique of using electrocoagulation first and later radium treatment.

Obstruction was mentioned as a reason for immediate surgery. We very commonly use a transverse colostomy even with acute obstruction and find it very useful.

We have been disappointed in preoperative roentgen treatment. We have usually used 400 kv. and we have not uniformly seen improvement such as has been described. We feel that although roentgen irradiation will occasionally shrink the tumor, if you are going to use preliminary treatment, a preoperative colostomy, pre-resection colostomy, will do the same and in addition to that will give the patient a certain immunity and allow you to straighten the patient out as far as his chemical balance goes.

Dr. Binkley spoke about the one- versus the two-stage operation. We have been employing the one-stage in 80 per cent and the two-stage in about 20 per cent of cases. Our objection to the Lahey operation has been that we get into the same operative field, into a measure of edema and adhesions and not infrequently just where you don't want them—around the corner where you are trying to get away from the ureter. That is one of the reasons why we went from the left lower quadrant to the right upper quadrant, as regards the abdominal incision.

The only objection to the procedure we suggest is the second-stage (or third-stage, if you will) closure of the transverse colostomy. We usually apply a clamp to the spur while the patient is still in the hospital recovering from his resection and we find the patients do not object to the third stage, which is a simple closure and necessitates being in the hospital eight to ten days.

We agree that both electrocoagulation and radium have their good points and bad, but we believe a combination of the two is a rather happy solution.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Publisher: CHARLES C THOMAS, 220 East Monroe St., Springfield, Illinois.

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 220 E. Monroe St., Springfield, Ill. Information of interest to all readers will be found on page iv.

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Forty-third Annual Meeting: Haddon Hall, Atlantic City, N. J. Oct. 6–9, 1942.

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Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., R. H. Stevens, Detroit, Mich., B. P. Widmann, Philadelphia, Pa.

Twenty-seventh Annual Meeting: Haddon Hall, Atlantic City, N. J., June 8–9, 1942.

EDITORIALS

DUODENAL ULCER: A REVIVAL OF INTEREST

SEVERAL circumstances have conspired to renew an interest in the subject of duodenal ulcer. Personal letters from Dr. A. E. Barclay, who is a research worker in radiology at the Nuffield Institute for Medical Research at Oxford University, and for a period in charge of radiological personnel under the Ministry for Health in the United Kingdom, told of the amazing increase and incidence of duodenal ulcer in the soldiers evacuated from Dunkerque. Later letters told of the tremendous increase in the development of duodenal ulcer in the civilian population of England following the blitzkrieg by means of Hitler's air raids over the cities and countryside of England.

In Barclay's letters early in the present war he related how necessary it was to take radiological specialists from the hospital and civilian practices because they were needed more as physicians and surgeons. Later letters told of the necessity of calling these radiologists back to conduct reliable roentgen studies of gastrointestinal symptoms because both soldiers and civilians had discovered that it was easy to simulate or feign the symptoms of duodenal ulcer. The roentgen diagnosis of duodenal ulcer with cicatricial niche is possible in almost 100 per cent, and it is worth while in cases with actual duodenal irritation or duodenal spasm.

Later letters told of the evacuation of the large London hospitals even before the bombing and destruction of metropolitan hospitals in London and elsewhere. Patients were moved to the country into hotels or former mental hospitals or into the homes on the large estates. There was coincident lack of facilities for reliable roentgen examinations in these hastily adapted new hospitalization centers. It has therefore been necessary to organize diagnostic and treatment teams of specialists who journey from one small hospital to another and use portable equipment. The roentgen equipment is almost identical with the bedside unit that the U. S. Army originated during the first World War for the hospitals in France and even in our own cantonments. This regionalization of hospitals in England has become organized quite thoroughly. So many of them are small that it is impractical to provide complete staffs and so they have resorted to this ingenious and practical scheme of traveling specialty teams.

Another circumstance that fits into this new mosaic of duodenal interest is found within the pages of a new book by Dr. George Crile entitled "Power, Intelligence and Personality." It is an analytical and anatomical study of the dissections, weighing and comparison of the relative weights of the brain, thyroid and adrenal glands of 3,776 different animals of all species; birds, reptiles, fish, even huge whales, were studied.

This book probably records the culmination of the personal studies of Crile upon the kinetic energy of humans and all animals. I recall having heard Crile expound upon his first steps in kinetic energy before the Kansas State Medical Society at Topeka about 1915. These studies led Crile into the expansion of Billroth's original theory of the neurogenic causation of peptic ulcer. Crile later argued the causative factor of hyperthyroidism and hyperadrenalism and the influences of the sympathetic nervous system in the development and course of duodenal ulcer. This theory of Crile can be discussed later.

Further emphasis for this revival of interest in duodenal ulcer is found in the July, 1941, *British Bulletin of War Medicine*. Two abstracts from Army sources and two from Naval sources show an alarming increase in gastrointestinal cases and a high incidence of duodenal ulcer among these dyspeptics. Graham and Kerr show that 31 per cent of admissions were for gastrointestinal cases and out of 246 consecutive cases that 135 were duodenal ulcer and 23 were gastric ulcer. Saffley records the roentgenological findings in a series of 320 dyspeptic soldiers. He found 34.7 per cent with duodenal ulcer, duodenitis in 2.2 per cent, gastric ulcer in 4.0 per cent, and duodenal ileus in 1.6 per cent. Allison and Thomas, reporting for the Navy, say that since the war the dyspeptics had all become worse. One hundred sailors and marines were the subject of their investigation. In 89 cases examined roentgenologically, they found 40 cases of duodenal ulcer, 9 cases of duodenal spasm, 1 case of duodenitis, and 7 cases of gastric ulcer. Even with this high incidence, they feel that the roentgen diagnosis is considered to have underestimated the frequency of ulceration. Allison, in analyzing etiological factors in this same group, attributed the majority to their shift to service food for many had dieted in civil life. He says that "Anxiety was not, apparently, an important factor, but abnormal personality trends were frequent, especially over-conscientiousness, a sense of frustration and swings of mood with depressive phases."

Another item in this revival of interest in duodenal ulcer is provided by the recent biography, "Berkeley Moynihan, Surgeon," by Donald Bateman. Our modern conceptions of duodenal ulcer date from Moynihan's 1903 publication entitled, "The Surgical Treatment of Gastric and Duodenal Ulcer." Bateman furnishes several pages upon this important contribution of Moynihan. For it was Moynihan who first differentiated between gastric and duodenal ulcer by the symptoms of the latter with the hunger pain, relief from food and alkalis or a glass of milk. Of course Moynihan advocated the operation of gastroenterostomy and argued against the usefulness of medical and dietetic management. In 1910 Moynihan wrote a book entitled "Duodenal Ulcer." A little later a small monograph was published by Barclay upon the "X Ray Diagnosis in Stomach and Esophageal Disease." Barclay was then radiologist to the hospital in Leeds where Moyniham operated during this decade from 1900 to 1910 when Moynihan was becoming enthusiastic over his ability to diagnose duodenal ulcer and cure it by operation.

The conflict between the surgeons who favored the operative treatment and the physicians who insisted with equal vehemence that duodenal ulcer yielded to medical and dietetic cure was personalized in Moynihan, the surgeon, and Sippy, the gastroenterologist. This friendly feud reached its climax at a meeting of the Chicago Medical Society in 1913 when Moynihan and Sippy engaged in a verbal battle royal. As a clinching argument Moynihan recited his classical story about the German, the Frenchman and the Englishman who sought to win a prize for the best essay upon "The Elephant." With his celebrated charm and humor Moynihan told about the German who, after gathering together all available literature upon the elephant, retired to his garret room and at the end of a year produced three volumes entitled, "An Introduction to the History of the Elephant." The Frenchman, after lunching with his sweetheart, called a cabby and drove with his mademoiselle out to the Bois and observed the elephant in captivity at the zoo. But, said Moynihan, the Englishman determined to study the elephant in its natural habitat. Therefore, he investigated where he could find the largest numbers of this species and then equipped an expedition for an extended trip to Narobi. At Narobi the Englishman secured guides and went on a safari and studied the elephant in his natural habitat. He dissected the elephant. He studied them from infancy

to adult life, and after carefully arranging his newly acquired knowledge, the Englishman undertook to write a true story of his experiences and observations of the elephant in its own natural surroundings and habitat. Moynihan, the guest from England, was permitted a temporary triumph much to the discomfiture of Sippy. Time has shown that the non-obstructive type of duodenal ulcer will yield to medical and dietetic care and that the gastroenterostomy should be reserved for the truly obstructive type.

Further testimony upon the increased incidence of duodenal ulcer is found in a discussion of the Assistant Medical Director of National Defense of Canada. He is reported as saying that "Duodenal ulcer constitutes one of our biggest medical problems. Of all non-effectives returning from overseas, 25 per cent are due to ulcer."

A press dispatch reports Dr. A. C. Ivy as saying that there has been a greater increase in peptic ulcers since Pearl Harbor than at any time since the Wall Street crash and the ensuing depression.

It is easy to agree with Crile that duodenal ulcer is a disease peculiar to civilized man and that its periods of activity correspond with periods of work, worry and fatigue.

E. H. Skinner

CASSIE BELLE ROSE THATCHER
1883-1942

DR. CASSIE BELLE ROSE THATCHER of Boulder, Colorado, died on January 18, 1942, in the Boulder-Colorado Sanitarium where she had been a patient for some time. She was born in 1883 near Galena, Kansas, and received her early education there. In 1910 she received the degree of B.S. from the University of Oklahoma, and in 1914 the degree of M.D. from Rush Medical College. For fifteen years she was head of the Department of Roentgenology of the Presbyterian Hospital in Chicago and was on the faculty of Rush Medical College. She later moved to

Boulder, Colorado, where she became radiologist to the Boulder-Colorado Sanitarium and Hospital and to the Porter Sanitarium and Hospital of Denver, which positions she held at the time of her death.

Dr. Rose Thatcher was recognized as being one of the ablest women in radiology. She was a member of the American Medical Association, the American Roentgen Ray Society, the Radiological Society of North America and was a diplomate of the American Board of Radiology.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: Haddon Hall, Atlantic City, N. J., Oct. 6–9, 1942.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual meeting: Atlantic City, N. J., June 10, 1942.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N. J., June 8–12, 1942.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Arkansas. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Drake Hotel, Chicago, Ill., Nov. 30-Dec. 4, 1942.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Warren W. Furey, 6844 S. Oglesby Ave., Chicago, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Florida. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. R. C. Pendergrass, Pendergrass Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY
Secretary, Dr. P. E. Heinert, 811 Huron Bldg., Kansas City, Kansas. Meets third Thursday of each month at a place designated by the president.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in April.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Hugh F. Hare, Lahey, Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. M. M. Pomeranz, 1020 Park Ave., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport. Next meeting, Necho Allen Hotel, Pottsville, Pa., May 15–16, 1942.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Annual meeting scheduled for Denver, summer of 1942, has been cancelled.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. L. W. Baird, Scott and White Clinic, Temple, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday each month, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress.
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

BULLETIN OF THE AMERICAN COLLEGE OF RADIOLOGY

RADIOLOGICAL SERVICES DURING THE WAR

With estimates of the prospective needs for physicians in the military forces ranging as high as 50,000, it is obvious that the depletion of those engaged in civilian practice will be severe. All indications point to a particular shortage of radiologists. There are approximately 2,800 radiologists of all degrees of competence in the United States, about 50 per cent of whom are under forty-five years of age. Of the total classified as radiologists, approximately 1,500 have been certified by the American Board of Radiology. These figures give an approximation of the supply of radiologists available for both the armed forces and the requirements of the civilian population. To meet the requirements of the Army and Navy, what will be the demand?

Military Demands

The Committee on Military Affairs of the American College of Radiology (the members of which also compose the Subcommittee on Radiology of the National Research Council) has for several months past been in frequent conference with representatives of the Surgeons General and the Procurement and Assignment Service. The most recent information obtained by the Committee indicates that there will be about 51,750 physicians under forty-five available for the armed forces after deducting the physically unfit, those retired, females, Negroes, aliens, and unlicensed graduates. For an Army of ten million men, 65,000 physicians will be needed. An estimated 4,200 will be required by the Navy.

On February 13, 1942, the Committee was advised that there were 163 radiologists in the Medical Corps as of that date. It was estimated that an additional 1,000 would be needed by the end of 1942 to fulfill the requirements of an Army of 3,600,000 men. The immediate demand for nearly 600 trained radiologists in the Army Medical Corps on the above date has since been fulfilled and the Committee was recently advised that there is at present no unfilled demand. Two sources have supplied radiologists to bring the personnel up to the desired number: Radiologists in the Organized Reserve, and regular officers of the Medical Corps who have completed short courses of basic roentgenological training in the Army Medical School.

The Committee on Military Affairs has recommended an expanded program to increase the number receiving basic training. The Army Medical School is presently turning out about 25 medical officers each month after completion of a four weeks basic course which prepares them to act as assistants to specialists in roentgenology. Another source of additional personnel will be supplied from the more than one hundred residents who will complete three year residencies this year and, presumably, each year thereafter. The requirements of the Navy are relatively small and are presently filled.

With this brief picture of the probable demands and the available supply of radiologists for the armed forces, it is apparent that there will not be a sufficient number of radiologists left in civilian practice to fulfill the medical needs of the civilian population with the same adequacy as before. Although the health needs of the civilian population are likely to increase rather than decrease, it is obvious that the demands of the armed forces will be met first and civilian needs will be met as best they can with the physicians left in private practice.

A Plan for Maintaining Radiological Service during the War

The radiologist who leaves a lucrative private practice and enters the service of his country is making a very real sacrifice. In order that the best service possible under the circumstances will be maintained for the civilian population, those carrying on at home must also make sacrifices. A mutual and patriotic spirit must prevail

among patients, hospital staffs, referring physicians, and radiologists remaining in private practice.

By authority of the Board of Chancellors of the American College of Radiology, the Executive Committee of the Board has prepared a plan, consisting of general principles, that is recommended for the consideration of community hospitals and regional radiological societies in adopting a course of procedure to meet the situation created by the emergency.

Objectives.

The plan has a three-fold objective:

1. To encourage radiologists of military age to volunteer for commissions in the armed forces;
2. To maintain the highest quality of radiological service for the civilian population that is possible under the circumstances;
3. To protect the interests of physicians in the armed forces during the period of their service.

The problems and the recommended solution will vary according to different situations and in each community. The procedure to be followed will depend upon the nature of the practice involved, the size of the community, and the number of qualified radiologists remaining in the community.

(*A*) *The Private Office.* If a radiologist entering military service has a private office, he may engage a locum tenens to care for his practice during his absence. If a physician can be obtained to carry on the practice on a full or part time basis, a simple solution is provided. A private contract can be entered into according to the agreement of the parties. If the absentee has a hospital practice in addition to his office practice, the agreement will usually cover both. In the latter event, the approval of the hospital staff and its administrators should be obtained for the locum tenens to substitute on the staff for the absentee. Further details of the agreement with the hospital are discussed below.

Where a locum tenens is engaged, his compensation is a matter for private negotiation. It is thought that, in the usual instance, 75 per cent of the net income from the practice, both in the office and hospital, would be a fair compensation and would allow an adequate sum to the absentee. (A sample contract for a locum tenens can be obtained from the American College of Radiology.)

Manifestly, increasing depletion of the civilian ranks will make it difficult, if not impossible, to obtain one individual to substitute for the absentee. This will call for a mutual pledge of cooperation on the part of all radiologists in the community. Two or more local radiologists may agree to divide the work, in which case their share of the net income would be divided according to the amount of time each contributed.

(*B*) *The Hospital.* It should be borne in mind that the interests of the hospital must be given full consideration in any plan adopted by a regional radiological society for maintaining the practice of their colleagues serving with the armed forces. While it is under a moral obligation to cooperate in a plan of such altruism, the hospital is under no legal duty to accept a substitute of another's choosing or to continue its contract with the absentee radiologist. However, instances will undoubtedly be rare in which the hospitals of a community fail to cooperate in attaining the objectives sought in the proposed program.

The problems involved in hospital practices will vary according to the nature and size of the institution, as well as the size of the community. They may be classified as follows:

1. *Full time teaching positions in large institutions:* Usually the director of such departments will be classified as essential for teaching and will not be called to military service. In the event he is called, he will probably have a teaching staff capable of carrying on in his absence. Otherwise, the situation may be met in the

same manner as for other hospitals, as outlined below.

2. *Full time positions in private hospitals:* Three possible solutions are presented:

(a) A locum tenens may be obtained and, after obtaining the approval of the hospital staff and administrators, a private agreement executed between the parties. Since the volume of work in such a department is commonly due in considerable degree to the efforts of the director, it would seem that a reasonable compensation to the locum tenens would be somewhere around 75 per cent of the net return, the balance going to the absentee.

(b) Radiologists remaining in the community may agree to look after the hospital practice of their absent colleague, and two or more may share in the conduct of the department. The approval of the institution would of course be necessary. The division of the income paid to the professional staff, between those performing the work and the absentee, should be agreed upon between the parties with the advice and recommendations of the hospital and the local radiological society.

(c) The hospital may obtain another radiologist to take over the department. As stated before, the hospital should, out of fairness, permit the physician entering service to select his own substitute, subject to the approval of the hospital. The appointment of the substitute should be temporary and the absentee should be guaranteed his place on the staff when he returns.

3. *Part time positions in private hospitals:* The practical, and perhaps the ideal solution for this problem will be for one or more local radiologists to care for the work during the absence of the man in service. Provided the income of the department is maintained at its previous level, there appears no reason why the hospital should not agree to continue its existing financial arrangement and pay the same percentage or salary to substitutes as was paid before. A portion of the net income of the practice would normally be sent to the absentee or his family.

Small Cities.

In some communities there will be only one radiologist conducting both a private office and one or more hospital departments. Usually the hospital department will not be large enough to warrant the engagement of another radiologist (even if such were available), and in this case the staff should be encouraged to content themselves with such service as a technical staff may provide. While this is far from a desirable solution, it will be the only one possible in many instances. Wherever possible a qualified radiologist from a neighboring community should be obtained to act as a consultant and visit the department at regular intervals.

Agreement Among Radiologists.

In setting out to draw up a plan for attaining the objectives outlined in the beginning of this discussion, the local radiological society or group of radiologists should first arrive at a common understanding and enter into a mutual agreement of cooperation. Though it may not be strictly necessary, it will usually be best to reduce the agreement to writing and ask each member to subscribe to it. A few basic principles to be incorporated in the agreement may be suggested as follows:

1. Those radiologists remaining at home shall agree to make a patriotic contribution in time and effort in the interests of any of their colleagues entering the service of their country. In doing so they will have made the first and most important contribution toward accomplishing the three objectives of the program: They will have encouraged their colleagues of military age to volunteer for military duty; they will have assured the best radiological service to the community that is possible under the circumstances; and they will have protected the interests of their absent colleague.

2. Any member entering service should

be free to enter into a private contract with a locum tenens or an individual radiologist in the community on any basis he desires. If, however, he needs the assistance of the local society or group, he should know that his practice will be looked after and the work will be shared by those staying at home.

3. A committee of three or more should be appointed to serve for the duration as advisers and mediators under the plan. It may be wise to ask an officer of the local county medical society to serve on the committee. This committee would be charged with the responsibility of determining the amount of time each radiologist could devote as a substitute in another office or hospital. It would offer advice to members entering service and make suggestions to the local profession of its work and endeavor to enroll the cooperation of referring physicians.

The committee should confer with the state chairman on Procurement and Assignment with a view toward obtaining deferment of radiologists who are essential for industrial and civilian practice. A sufficient number of individuals should be classified as essential to provide at least a minimum of radiological service in the community. It may become the responsibility of the committee to designate the individuals to be classified as essential.

4. A reasonable portion of the net income of the practice, over expenses, should be reserved for the absentee. In some communities the radiologists have already agreed that they will look after the practice of any colleague in the service and send him the entire net income after actual expenses are deducted. Normally, a fair portion of the net income will be divided among those performing the work.

5. In the case of a private office, the entire local profession should be advised that the practice will be continued by certain individuals and an appeal should be made for physicians who have referred work to the absentee to continue to send it to his office. The technical and clerical staff should be kept intact and all bills should be rendered on the bill head of the absentee. Reports should be signed by the substitute "for Dr. Blank," the absentee.

6. In the case of hospital practices the same general plan would be followed, but it would of course be necessary to reach an agreement with the hospital and obtain its approval for substituted service by one or more local radiologists. A meeting between the appointed committee and hospital representatives should be arranged for the purpose of securing the approval and support of hospitals in the plan.

Agreement Among Hospitals.

In connection with the maintenance of hospital service, a plan recently adopted by the Chicago Roentgen Society is of interest. A committee of three was appointed which sent a questionnaire to every member of the society to determine what hours each could devote in providing service in a hospital temporarily without a radiologist. The members were also asked to indicate the areas of the city they could most conveniently serve. Although any member was free to enter into a private contract with a locum tenens, the society officially stated its policy that after reasonable expenses and any losses from his own practice were deducted a substitute should pay over the net income from the hospital practice to the absentee. It is anticipated that in some instances several radiologists will be required to alternate in a department which has had a full-time director. The plan is presently functioning with apparent success.

Cooperation of the local hospitals is essential if the problems created by the emergency are to be solved with success. A program of the nature of the one described herein is manifestly completely altruistic and patriotic in its motives and it seems unlikely that any hospital would offer objections. However, the hospitals must agree to accept substitutes and they must be

content to get along with less complete service than they are accustomed to. The hospital administrators, medical staffs, and patients must realize that less than ideal conditions will prevail as a result of the emergency. They will be called on to share in the sacrifice made by the radiologist entering service and his colleagues who agree to render the service in his absence.

It will be necessary for those hospitals fortunate enough to retain their radiologist to consent to his contributing a portion of his time to other hospitals when called upon to do so for the welfare of the community at large. All these problems should be discussed in a conference with representatives of the hospitals in the early stages of the proposal. In all probability there will be an acute shortage of radiologists in civilian practice and it should be clearly understood by hospitals that temporary adjustments must be made. They will find it increasingly difficult to obtain a new radiologist for full-time, or even part-time, service. The practical solution provided in a proposal of this type should receive their complete cooperation.

Different problems will be presented according to the type of financial arrangement existing between a hospital and a radiologist whose work is to be carried on by substitutes during his period of service. They may be briefly discussed under the following classifications:

1. *Rental arrangements:* Where the radiologist pays a fixed rental or a rental based upon a percentage of the gross receipts of the department, his legal status is that of a tenant. He is not an employee or agent and normally will be free to sublet to one or more radiologists, presuming they are acceptable to the staff and the administrators. In such cases the rental would remain the same and the division of the net income of the department would be a matter for negotiation with the substitutes.

2. *Percentage arrangements:* Some contracts are of such a nature as to make the radiologist an employee of the hospital on a commission basis. As stated before, the hospital is under no legal duty to accept a substitute or to continue the contract under existing terms. Usually, however, it seems certain that the hospital would recognize its moral duty to participate in a program advanced for the welfare of the community, and would consent to a substitute acceptable to the staff. In most instances the same percentage would be paid to the substitute as was paid to the absentee and the division of this sum would be left to these parties. Where the volume of work or the receipts of the department materially decreased by reason of less time from the temporary director, it might become necessary to reduce the percentage to the director to offset increased expenses incurred by the hospital.

3. *Salary arrangements:* Where the director of the department is employed on a salary, the compensation to the substitutes would depend upon the amount of time they were able to give to the department in relation to that formerly given by the radiologist whose place they were filling. If the same amount of time were rendered the salary would usually remain the same and would be divided among the substitutes according to the period each devoted. They in turn would divide on an agreed basis with the absentee. The advice of the committee of the radiological society should be helpful in reaching an agreement on these matters.

Summary

The essential principles of the plan here proposed may be summarized as follows:

1. It is obvious that demands of the armed forces will create an acute shortage of radiologists available for the health needs of the civilian population.

2. To solve the problems created by the emergency, the American College of Radiology proposes the adoption of a plan having a three-fold objective:

(a) To encourage radiologists of military age to volunteer for commissions in the armed forces;

(b) To maintain the highest quality of

radiological service for the civilian population that is possible under the circumstances; and

(c) To protect the interests of physicians in the armed forces during the period of their service.

3. The plan calls for a spirit of cooperation among radiologists, hospitals and referring physicians in the community.

4. A special committee of radiologists, with perhaps a member representing the county medical society, should be appointed to work out the program best suited to the community. The members of the committee would act as advisers and mediators under the plan. The committee should confer with the state chairman of Procurement and Assignment concerning the deferment of radiologists essential for civilian practice.

5. A meeting should be held with hospital representatives to secure the approval and cooperation of the hospitals according to a specific plan of procedure.

6. Where one or more radiologists substitute in the private office of a man entering military service, referring physicians should be publicly urged to continue to send their patients to the office. Bills should be sent and reports signed in the name of the absentee. An agreed portion of the net income should be reserved for the absentee.

7. The arrangement in hospitals will vary as to whether the position is full or part time, and according to the existing fiscal arrangement between the radiologist and the hospital. Inasmuch as a new radiologist will not likely be available, local men remaining at home will usually be called upon to share in the work.

8. Members of the local radiological society should be asked to pledge their cooperation and subscribe to a specific set of principles.

9. Hospitals should grant leaves of absence to radiologists entering the service of their country and should agree to accept one or more substitutes to carry on the work, provided they are acceptable to the staff and the institution. Those hospitals retaining their radiologist should consent to his devoting a portion of his normal time to other departments, if called upon to do so.

INDIANA ROENTGEN SOCIETY

The fifteenth annual meeting of the Indiana Roentgen Society was held at the Indianapolis Athletic Club on May 24, 1942. Following a business meeting at which Dr. Wemple Dodds was made President-elect, Dr. Cecil Wright, Vice-President, and Dr. Harold C. Ochsner, Secretary-Treasurer, interesting cases were presented and discussed by members of the Society. After dinner the paper of the evening was given by the invited guest, Dr. Lawrence Reynolds of Detroit, Michigan, on the subject "Roentgen Evidence of Injury to the Internal Semilunar Cartilage." The meeting was attended by forty-five members and guests among whom were a number of the local orthopedists and members of the staff of Billings General Hospital at Fort Harrison.

RADIOLOGICAL SOCIETY OF NEW JERSEY

At the annual meeting of the Radiological Society of New Jersey held in Atlantic City on April 22, 1942, the following officers were elected: *President*, Dr. W. J. Marquis; *Vice-President*, Dr. H. A. Vogel; *Secretary*, Dr. H. J. Perlberg; *Treasurer*, Dr. C. Oderr; *Counsellor*, Dr. C. A. Plume.

NEW YORK ROENTGEN SOCIETY

At the meeting of the New York Roentgen Society held on May 18, 1942, the following officers were elected for 1942–1943: *President:* Dr. Roy D. Duckworth, White Plains, N. Y.; *Vice-President:* Dr. Paul C. Swenson, New York, N. Y.; *Secretary:* Dr. Maurice M. Pomeranz, New York, N. Y.; *Treasurer:* Dr. Haig H. Kasabach, New York, N. Y.

OHIO STATE RADIOLOGICAL SOCIETY

The annual meeting of the Ohio State Radiological Society was held as a business

luncheon at the Neil House, Columbus, Ohio, on April 30, 1942. The meeting was well attended, members being present from all the cities of Ohio. The guests were Dr. John H. Lawrence, Berkeley, California, and Dr. Merrill C. Sosman, Boston, Massachusetts. The officers elected for the ensuing year were as follows: *President:* Dr. U. V. Portmann, Cleveland, Ohio; *Vice-President:* Dr. E. C. Baker, Youngstown, Ohio; *Secretary-Treasurer:* Dr. J. E. McCarthy, Cincinnati, Ohio.

TENNESSEE RADIOLOGICAL SOCIETY

The annual meeting of the Tennessee Radiological Society was held at the Peabody Hotel, Memphis, Tennessee, on April 15, 1942. The guest speaker was Dr. Robert J. Reeves of Duke University, Durham, North Carolina. The following officers were elected for the ensuing year: *President:* Dr. Horace D. Gray, Memphis, Tenn.; *Vice-President:* Dr. Franklin B. Bogart, Chattanooga, Tenn. *Secretary-Treasurer:* Dr. J. Marsh Frère, Chattanooga, Tenn.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

An announcement has been received from Dr. John S. Bouslog, Chairman of the Program Committee, stating that the annual meeting of the Rocky Mountain Radiological Society which was to have been held in Denver on August 6, 7 and 8, 1942, has been cancelled because so many of the members have entered the Service.

Vol. 47, No. 6

DEPARTMENT OF TECHNIQUE

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A NEW TABLE FOR CYSTOSCOPY, ROENTGENOSCOPY AND ROENTGENOGRAPHY

By DAVID M. DAVIS, M.D.
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PHILADELPHIA, PENNSYLVANIA

ROENTGENOSCOPY of the urinary tract has been little used, largely because it is difficult to carry out because of the lack of suitable and practical apparatus. With the equipment to be found in many hospitals, it would be necessary to perform cystoscopy on one table, roentgenoscopy on another, and roentgenography on a third. So much moving of the patient is troublesome for the attendants, and painful for the patient. Tables on which both cystoscopy and roentgenography can be performed are now very common, but few indeed include arrangements for roentgenoscopy. The need for roentgenoscopy is little recognized, even today, yet there are numerous reasons why it is greatly desirable.

In an article written in 1929, Warren and myself* outlined some of these reasons, as follows:

> The fluoroscope offers a great deal in connection with urography. By its aid one can determine immediately the location of the catheters and their relation to any stone shadows; one can watch the pyelographic medium as it gradually fills the pelvis, massaging the kidney region, if necessary, and making certain that complete filling has occurred; and one can determine with accuracy the engagement of ureteral calculi by stone removing instruments and see whether the calculi have been moved or extracted by these devices. Fluoroscopic examination of the patient before the instillation of the opaque medium indicates the position of the catheters and also yields information which materially changes the usual procedure. Poor position of the catheters, coiling within the kidney pelvis, or undue pressure by the tip of the catheter upon the pelvis or a calyx can be remedied. The opaque fluid is run in under graduated pressure and the volume and time of the filling readily controlled. The kidney and ureteral regions can be palpated under direct observation and the mobility of these organs studied in detail. The emptying time of the kidney pelvis can be studied by subsequent fluoroscopy of the kidneys every few minutes, after the catheters have been removed, until the kidney pelvis is empty. The procedure causes the patient no extra discomfort and in fact may lessen the pain frequently experienced when the pelvis is over-distended during the usual method of instillation of the opaque fluid.

The publication in which these words appeared described an apparatus by means of which the patient could be moved easily from the position of cystoscopy to the roentgenoscopic apparatus. This was managed by placing the patient on a flat carrier resting upon ball bearings and arranged to slide lengthwise along the cystoscopic and roentgenoscopic tables, which were locked together for the purpose. While cumbersome, this apparatus functioned well.

Dr. Willis F. Manges, of Philadelphia, was a pioneer in roentgenoscopy of the urinary tract. He designed and had made a table for cystoscopy, roentgenoscopy and roentgenography. When I came to the Jefferson Hospital five years ago, I had the opportunity of using the Manges table, and

* Davis, D. M., and Warren, S. L. New combined table for cystoscopy, roentgenography and fluoroscopy. *J. Urol.*, 1929, *22*, 339–346.

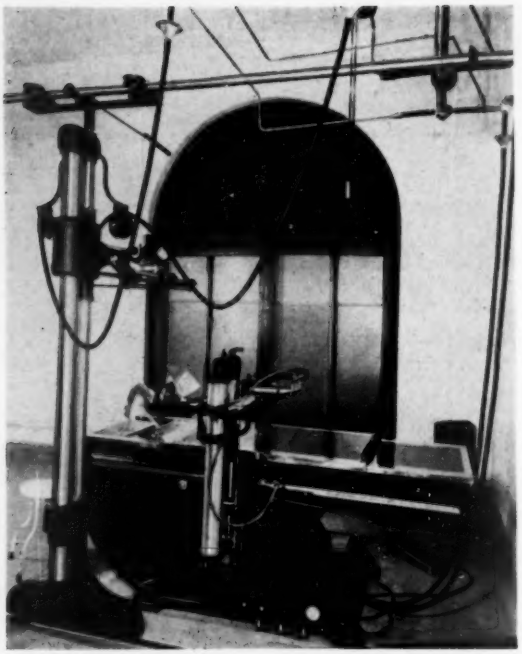

FIG. 1. General view of left side of new table for cystoscopy, roentgenoscopy and roentgenography. The carrier is shown, its lower end marked by knee-rests, drawn back in position for roentgenoscopy.

renewed my enthusiasm for uro-roentgenoscopy. Being an experimental device, the roentgenographic part of the Manges table was far from perfect, and frequently gave annoyance by getting out of order. In addition, the table suffered from a shortcoming common to all cystoscopic-roentgenographic tables; namely, that in the cystoscopic position, the patient was not in the proper position for either roentgenoscopy or roentgenography, and had to be drawn upward on the table for a distance of 3 to 6 inches. I strongly desired to construct a new table which should avoid these shortcomings, and perhaps have some special advantages of its own.*

The central and exclusive feature of the new table is a sliding carrier, very similar to the one used by Warren and myself in 1929. The carrier is now used, however, not to transport the patient for a long distance between the roentgenographic table and the roentgenoscopic table, but to permit the patient to be drawn back from the cystoscopic position at the end of the table to a point where a film can be taken or the roentgenoscope used with equal facility and perfect centering. To this end, the carrier (*a*) moves smoothly and easily on ball bearings, (*b*) has a semi-automatic stop which fixes it at any one of eight different locations along the table top, (*c*) is equipped with completely adjustable knee-rests which do not project below the level of the carrier, and therefore do not interfere with its movements, and (*d*) has an adjustable clamp for a cystoscope holder so that the cystoscope can be held firmly and steadily in place

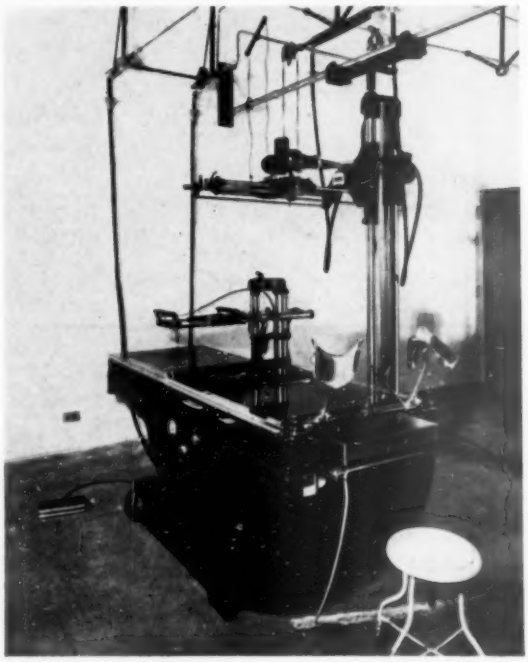

FIG. 2. View of table showing carrier drawn down to cystoscopic position. Note cylindrical bar at foot of carrier, with adjustable cystoscope holder and completely adjustable knee-rests. The bar can be rotated by pulling out the buttons at either end of it. Near the base of the right knee-rest is the catch which holds the carrier in the position desired. Note the large drip-pan drawn out in position for cystoscopy, and the free space for the cystoscopist's knees.

* Funds were available for the purpose, thanks to the generosity of Mr. Jacob Lit, and the project met with the approval of the Board of Trustees of the Jefferson Hospital. Mr. William Hogan, of the Franklin X-ray Corporation of Philadelphia, lent himself enthusiastically to the problems of design and construction.

while the carrier is being moved back and forth.

This carrier has also solved the problem of the drain-pan, which in older tables invariably interfered with the roentgen apparatus, since the latter had to be brought as near to the lower end of the table as possible. Now the drain-pan can be designed on generous and practical lines, as there is no need to bring the roentgen apparatus to the lower end of the table. The pan is of large size, has adequate excursion, and can be moved easily by pressure at any point along its front edge, at the ends as well as in the middle.

From a roentgenological point of view, the table is built upon the foundation of a more or less standardized roentgen table. It rests on a heavy base, and is equipped with an electric motor which moves the table top from a 30 degree Trendelenburg position to a 90 degree upright position. The axis of rotation is so placed that the lower end of the table just misses the floor when in an upright position. There is a detachable foot-rest for use when the patient is in the erect or upright position. The special feature of the table top is that there are beneath it no cross members whatever for a distance of 24 inches from the foot of the table, giving completely adequate space for the cystoscopist's knees.

Fig. 3. Cystoscopic position, patient on table. Note cystoscope holder, also step to assist ambulant patients in mounting table.

Fig. 4. Carrier and patient drawn back to roentgenoscopic position. Drip-pan in non-use position.

The roentgenoscopic apparatus runs on a rail along the left side of the table, and is counterbalanced so that it can be placed wherever desired regardless of the angle of the table top. The unit is completely shock-proof, the tube moves with the screen, and the shutters are actuated by double handle grips on the end of the screen near the operator (Fig. 4).

The roentgenographic tube is also shock-proof, and is universally adjustable upon a strong, rigid upright moving upon a floor track and an elevated guide. When the table top is level or nearly so, the tube is easily and quickly centered over the film by means of scales attached to the elevated guide and to the frame of the table just under the cassette holder. The cassette

FIG. 5. Patient and carrier in same position as in Figure 4, roentgenoscope pushed away; tube support, Potter-Bucky diaphragm, and cassette holder brought up ready for roentgenography.

holder and Potter-Bucky diaphragm are counterbalanced, so that they slide easily out of the way when one wishes to use the roentgenoscope. When the cassette holder is pushed home, it and the Potter-Bucky diaphragm are raised automatically against the lower surface of the table top, to bring the film as close as possible to the patient. Automatic exposure and Potter-Bucky timing devices are of course included.

The operation of the table is extremely simple. The roentgenoscopic screen and roentgenographic tube are pushed out of the way. The carrier is brought to its highest position near the head of the table. The right knee-rest is removed from its socket. The patient then lies upon the carrier, or is lifted on it from a stretcher. The right knee-rest is then replaced, the patient centered, his knees placed in the rests, and the latter adjusted to the desired position. The knee-rest supporters can be lengthened or shortened, moved laterally upon the round bar at the foot of the carrier, or put at any one of four different angles, from vertical to almost horizontal. The carrier, with the patient lying comfortably upon it, is run to its extreme position at the foot of the table, and cystoscopy carried out in the usual manner (Fig. 2 and 3). When the catheters are in place, the cystoscope is supported by a clamp, which has also clips for holding the test tubes which contain the ends of the catheters. (The sheet used to cover the patient must have a small hole to permit the passage of the clamp.) The carrier, with patient, clamp, cystoscope and catheters, is then slid back about 18 to 24 inches. Experience shows that if the cystoscope is held absolutely motionless in this manner, pain is reduced to the minimum. The roentgenoscope is brought into position, and the room darkened. A small, sterilizable lamp may be attached to the cystoscope holder, and illuminated by attaching to it the cystoscopic cord. This gives a subdued light where needed to inspect the connec-

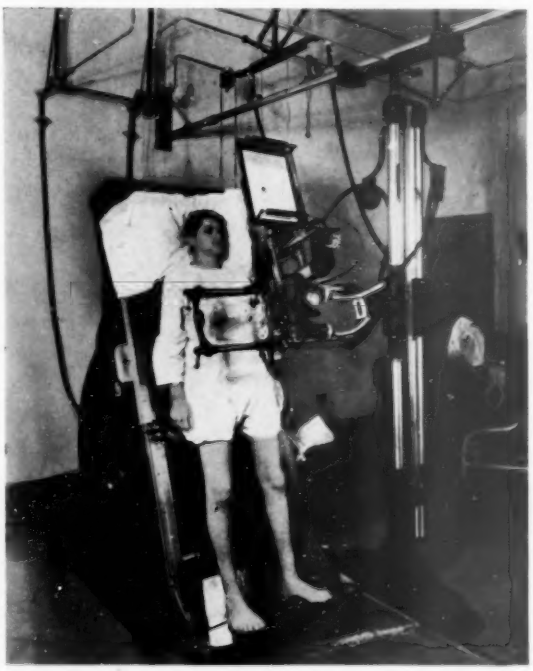

FIG. 6. Roentgenography in erect position. Note the large, rigid foot-rest. The patient is still on the carrier, and the cystoscope can be left in place, even in this position, if desired. The right knee-rest has been removed from its socket. The roentgenoscope can also be used in the upright position.

tions between the ureteral cathers and the syringes or burettes used for injecting the pyelographic medium. The injection is controlled by roentgenoscope. When it is complete, the roentgenoscope is pushed aside, the tube stand and Potter-Bucky diaphragm drawn into place, and the desired films made (Fig. 5). Either roentgenoscopy or roentgenography can be carried out in the erect position if desired (Fig. 6). All of this is accomplished without any jerk or jar to the patient, and, unless the erect position is used, without altering in the slightest his position on the carrier.

The tube carrier is so contructed that a rotating anode tube can be used, if desired.

The latest model has been greatly improved by a worm and sector device to control the tilting of the knee-rests.

While the table is still new, sufficient experience has already been gained to show that with it examinations can be carried out with ease, satisfaction, and comfort to the patient never before realized.

A HOME MADE BUCKY POLYGRAPH

By LOUIS NATHANSON, M.D., *and* M. MORRIS WITTENBERG
From The Department of Roentgenology, Jewish Sanitarium and Hospital for Chronic Diseases
BROOKLYN, NEW YORK

WE HAVE been using a home made Bucky polygraph for the past year or so with excellent results. The cost is entirely that of a cut-out lead shield which can be obtained for approximately $3.50. No other apparatus is necessary except a wooden mask which is placed in the Bucky tray to permit the exact shifting of an 8 by 10 or 10 by 12 inch film depending upon the size of the Bucky tray in use.

A 14 by 17 inch piece of lead 1/16 inch thick, with a cut-out $3\frac{7}{8}$ by $4\frac{7}{8}$ inches directly in the center, is placed between two layers of ray board with four rubber grips placed in the corners to prevent movement of the shield. The lead covers the entire shift of the film, and the cut-out is $\frac{1}{8}$ inch less than the actual size of the cut-out on the film to allow for the distortion between the shield and film. The wooden mask must be made according to the size of the cassette and Bucky tray used. With the new type tray and an 8 by 10 inch film, we use the U-shaped mask with the dimensions described in Figure 1. This mask is turned once in the tray between the second and third exposures. In this way four 4 by 5 inch cut-outs are obtained on an 8 by 10 inch film.

Our procedure is as follows: The Bucky is first moved out of the field and the lead shield is placed so that the cut-out is centered to permanent cross lines on the table (Fig. 2). The patient is then manipulated roentgenoscopically so that the part to be examined is visualized in the center of the opening. The fluoroscopic screen and tube are moved away and the Bucky tray and tube are centered to the same cross lines on the table top. The Bucky exposures are now made in the usual manner, shifting the cassette manually between each exposure. The wooden mask is turned as previously mentioned between the second and third exposure.

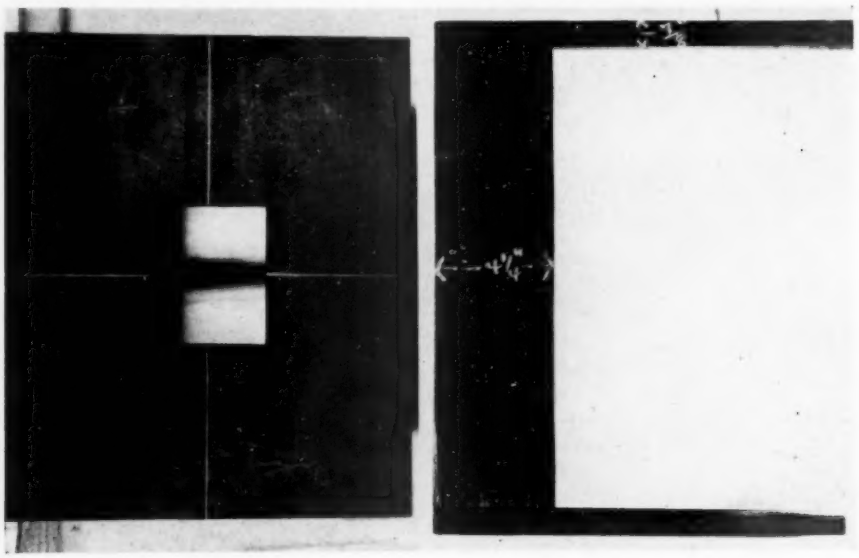

FIG. 1. Shows the lead shield with cut-out and wooden mask.

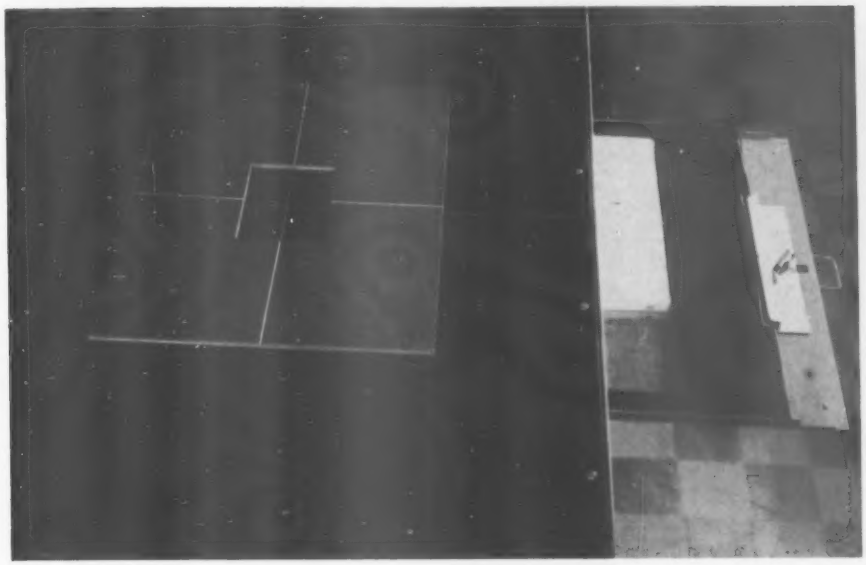

Fig. 2. Showing shield centered to crosslines on table, also wooden mask and cassette in Bucky tray.

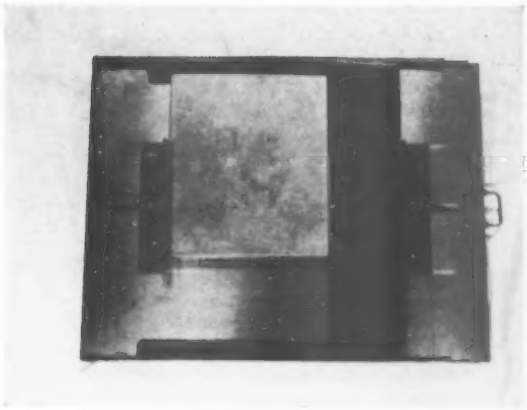

Fig. 3. Cassette and mask in tray.

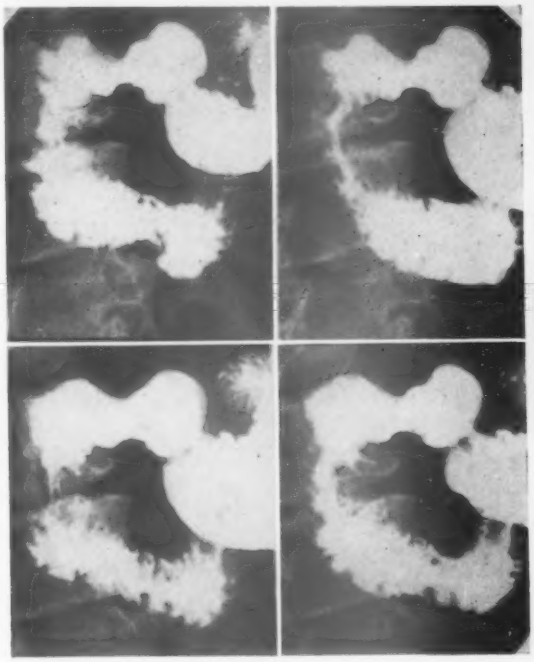

Fig. 4. Resulting roentgenogram showing four 4 by 5 inch studies on one 8 by 10 inch film.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

Oppenheimer, A. Longitudinal fissures in the vertebral articular processes. *J. Bone & Joint Surg.*, April, 1941, *23*, 280–282.

Radiolucent lines are found in the neural arch and its processes due to persistence of cartilage and failure of union of parts arising from separate centers of ossification. These occur in the lamina, between the superior and inferior articular processes and at the ends of the inferior articular processes. The author found 4 patients in whom a new type of fissuring was present. This was a longitudinal fissure which extended from the region of the isthmus in the longitudinal axis of the articular process down to the transverse fissure which was always found in association at the tip of the processes. The line was serrated and suggested fracture although none of the patients had suffered a severe trauma. The association of this type of fissure with transverse fissures at the tip of the processes suggests a developmental anomaly as the cause.

The importance of these fissures lies in possible erroneous interpretation as a fracture.—*R. M. Harvey.*

Müller, Walther. Die Perthessche Krankheit als Erscheinungsform der Ermüdungs- und Abnutzungsreaktionen des Skeletts und ihre Abgrenzung gegenüber den verschiedenen Epiphysenstörungen. (Perthes' disease as a manifestation of a fatigue reaction in the skeleton and its differentiation from various epiphyseal disturbances.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1941, *63*, 247–267.

The nature of osteochondritis deformans coxae juvenilis has been a mystery since the first descriptions by Perthes, Calvé, and Legg in 1910. A true Perthes' disease may be simulated by congenital epiphyseal disturbances and by changes occurring in a congenital dislocation of the hip which has been reduced. The faulty explanation of the pathogenesis of true Perthes' disease has various causes. Symptoms appear rather late and are not severe so that only late stages are observed. The theories of trauma (Kappis) and embolism (Axhausen) as an explanation of the subchondral necrosis observed pathologically have not been generally recognized. Too often investigation has been confined only to the hip joint. The author regards the demineralization of the bone structure, the changes in the shape of the acetabulum, femoral neck and epiphysis as simultaneous and comparable manifestations of a degenerative process. Illustrative of this viewpoint is the case of an eight year old boy who exhibited signs of wear and tear in the bone structure with insufficiency fractures in the upper tibia. A year later following a fall, a typical Perthes' disease developed in the left femoral head where the bone structure had been shown previously to be quite normal. The basis for the general skeletal disturbance was thought in this instance to be a dystrophia adiposogenitalis. Köhler's disease and Deutschländer's disease are also local manifestations of a skeletal inferiority. The author has already described the small circular shadows which appear in the femoral neck during Perthes' disease and which are believed to be cartilaginous nodules analogous to those seen in the spine in adolescent kyphosis.

The author further relates certain hereditary and familial disturbances of the epiphyses to osteochondritis dissecans and to true Perthes' disease regarding the deficiency of the bone structure as congenital in character in the former two conditions and acquired in the latter. A close similarity also exists between the pathogenesis of the changes in the femoral head sometimes observed following reduction of a congenital dislocation and those in true Perthes' disease, but in the latter by contradistinction there is a broadening of the femoral neck by periosteal overgrowth and an alteration of the bone structure which the author regards as the primary lesion in Perthes' disease. He recommends that the hip be examined with the thigh in abduction and external rotation (Lauenstein's position) to detect the earliest changes.—*W. A. Evans, Jr.*

BARBIERI, ARRIGO. Due casi di frattura del sopracciglio del cotile. (Two cases of fracture of the rim of the acetabulum.) *Radiol. med.*, Jan., 1941, *28*, 47–48.

In a recent number of *Radiol. med.* a case of fracture of the rim of the acetabulum with subluxation of the femur was reported and the statement made that only about 70 such cases had been reported in the literature.

The author thinks that this rarity is to a certain extent only apparent and due to the fact that physicians do not report it. A number of cases have been reported recently. As a rule, the injury is caused by automobile accidents, the blow which the patient receives on the knee when hurled against the front of the car by the sudden stopping of the machine being transmitted through the femur to the acetabulum.

The author reports 2 cases, the first in a man of forty-seven who was struck in the left flank and hurled to his knees, the weight of the body falling on the right knee. He felt a violent pain in the right coxofemoral joint and could not rise to his feet. Roentgen examination showed that a large fragment was broken from the posterior border of the acetabulum with posterior subluxation of the head of the femur.

The second case was in a man of thirty-seven who was struck in the back and fell to his knees with the trunk bent forward. Evidently the trauma acted indirectly on the left hip, probably favored by defense movements on the part of the patient. The roentgen examination showed findings similar to those in the first case.

The interest of the cases, aside from their rarity, lies in the fact that they were not caused by sudden direct violence as in automobile accidents, but slowly, and rather by the action of weight than that of acute violence. The proof of this lies in the fact that the patients were not injured in the part of the body that was struck.

Diagnosis of these cases must be made solely by roentgen examination. Clinical diagnosis is wrong in 90 per cent of the cases.—*Audrey G. Morgan.*

FORRESTER-BROWN, M. Slipping of the upper femoral epiphysis; end results after conservative treatment. *J. Bone & Joint Surg.*, April, 1941, *23*, 256–262.

The author reports a conservative method of treatment of slipping of the upper femoral epiphysis practiced in a series of 11 out of a total of 22 cases treated with varying methods.

In the earlier cases the author considered primary loosening of the fragment to be essential and used Kirschner wire traction. However roentgenograms showed that the traction served only to pull the head of the femur below the acetabulum without changing the relation of the head to the neck. In the final 11 cases of the series the affected hip was brought into full internal rotation with the leg in extension and a plaster spica applied. The patient is allowed to walk as soon as the cast is dried and is roentgenographed again in three months. A lateral roentgenogram with the leg in the "frog" position is valuable to show the relation of the head to the neck. Plaster immobilization is maintained until trabeculae can be demonstrated crossing the epiphyseal line.

The above-described conservative method of treatment does not carry the risk to life that the operative method of treatment carries and in addition does not have the possibility of damage to the articular cartilage. Although perfect anatomical reduction may not be obtained the author feels that functional results are good.

In 19 of the 22 cases endocrine dysfunction was present and thyroid and whole pituitary gland were used as adjuncts to the manipulative procedure. The average resultant shortening of the leg in this series was only one-half inch. Most of the cases occurred between the ages of twelve and sixteen. Two sets of roentgenograms are included in the article to illustrate the good results obtained by this conservative method of treatment. The author concludes that early diagnosis is the really important measure.—*R. M. Harvey.*

CARRELL, B., and CARRELL, W. B. Fractures in the neck of the femur in children with particular reference to aseptic necrosis. *J. Bone & Joint Surg.*, April, 1941, *23*, 225–239.

This is a study of fractures in the femoral neck in 10 children. This fracture is rare in children and usually occurs at the cervicotrochanteric junction. Satisfactory reduction is more difficult than in adults and the incidence of aseptic necrosis higher. The authors found that traction and abduction combined are necessary for reduction and its maintenance. In some cases tenotomy may be required of the adductor group in order to secure complete abduction. Various methods of traction were used. Three patients had open reductions.

The next problem after that of reduction and its maintenance is that of aseptic necrosis. The authors advise avoidance of vigorous manipulation in the primary reduction and a long period of freedom from weight bearing as aids in prevention of this complication. Aseptic necrosis occurred in 33.3 per cent of their cases. Wolcott has shown that the pattern of vascular anastomosis in the hips of children up to ten to thirteen years of age differs from that in adults in 80 per cent of cases. In adults the capsular vessels enter in two groups at the postero-inferior and postero-superior juncture of the cervicotrochanteric region and anastomose with the nutrient and ligamentum teres vessels. In 20 per cent of adults the ligamentum teres vessel is absent and in all children up to the age of eleven to thirteen this vessel is not patent beyond the fovea. At this age the nucleus of the head is well formed.

The authors feel that this lack of anastomosis of the capsular vessels and the vessel of the ligamentum teres is a factor in the production of aseptic necrosis in children, as a complication of fractures of the hip.—*R. M. Harvey.*

Baker, L. D. Spontaneous fracture of the femoral neck following irradiation. *J. Bone & Joint Surg.*, April, 1941, *23*, 354–358.

The first reports of this entity were published in 1926. No report of this entity appeared in the American literature until 1936. Pathological studies in these reports revealed obliteration and sclerosis of the vessels, increase in fatty marrow between narrowed trabeculae, bone absorption, lack of new bone formation and no evidence of metastasis at the fracture site.

Most of the reported cases have no history of trauma. Pain preceded the occurrence of fractures by seven months on the average. Callus formation is not likely but sufficient fibrous union may occur to permit partial return of function. Treatment is not yet standardized.

The authors report a case in a fifty-nine year old female who was treated for carcinoma of the cervix with 400 kv. at 70 cm. target-skin distance; 3,000 roentgens, as measured in air presumably, was the dose to each of two anterior and posterior portals, 10×15 cm. The filter was 4 mm. of copper. The total dosage was administered in three weeks with daily treatments. Approximately six weeks later 4,500 mg-hr. of radium was given with intrauterine and intravaginal applicators; 2,500 mg-hr. was given through a vaginal applicator.

Six months later the patient first complained of hip pain. Five months later a film revealed an incomplete fracture of the femoral neck. The patient was advised to remain in bed for two weeks and return for another roentgen examination in four weeks. She returned in two months and at this time the fracture was complete. There was some absorption of the neck and upward riding of the shaft. There was no evidence of metastasis.—*R. M. Harvey.*

Kulowski, J., and Luck, J. V. Microscopic changes after internal fixation of transcervical fracture of the femur. *J. Bone & Joint Surg.*, Jan., 1941, *23*, 17–22.

The authors state that pathological changes and resistance to former methods of treatment, peculiar to intracapsular fracture of the hip, account for the widespread acceptance of the principles of internal fixation now in vogue. Despite the interest evinced in these injuries there are, in the literature, very few complete pathological studies of the fracture site so treated. They describe the microscopic findings in such a postmortem specimen. It was obtained from an elderly woman fifty-two days after injury, and forty-three days after transfixation by Smith-Petersen nail. Death was probably due to a cardiovascular complication.

The several features which were outstanding on the basis of their microscopic examination were:

1. The simplicity of and the rapid progress made by the healing process.
2. The absence of cartilage from the healing process at the fracture site.
3. The absence of subperiosteal reaction or peripheral callus.
4. The minimal evidence of trauma inflicted by the insertion of the pin.
5. The minimal reaction of the tissues to the presence of the pin.
6. The absence of significant osteoporosis, and the apposition of new bone on trabecular surfaces at such an early period after fracture.

They believe it is quite clear from the study of their specimen that any method of internal fixation which meets mechanical requirements —such as good reduction, elimination of shearing stress at the fracture site, and adequate fixation of fragments which are and remain in an excellent state of nutrition—will result in

bony union much sooner than has been generally appreciated in the past.—*R. S. Bromer.*

SCHINZ, HANS R. Aussen- und Innenrotationsbruch des Unterschenkels. (External and internal rotation fracture of the tibia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1941, *63*, 163–167.

In 1899 Zuppinger described the roentgen appearance of fractured lines in the tibia and reported 23 cases of torsion fracture, 22 of which were due to external rotation of the foot, and only 1 to internal rotation. These screw-shaped fracture lines run from the lower medial to the upper lateral aspect in the external rotation fracture, and the distal fragment tends to be displaced laterally followed by contraction of the muscle and overriding of the fragments. In recent years there has been a marked increase in torsion and spiral fractures, both internal and external varieties, in the Zürich Surgical Clinic attributed to the increase in transportation accidents and sport mishaps, particularly in skiing. One should not attempt to correct the rotation of the fragments except when strong traction has been applied; in other words, it should not be done by first aid workers as the deformity is increased sometimes with the interposition of soft parts between the fragments and correction in hospitals is made more difficult. A review of present day fractures shows that those due to external rotation will predominate but only by a ratio of 2:1 over those due to internal rotation. In adults the fibula is usually involved, near the head in the external rotation fracture and about the malleolus when the foot is internally rotated. The same principles apply to torsion fractures involving the other long bones.—*W. A. Evans, Jr.*

KLINKE, J. Zur Frage der Osteochondritis dissecans patellae. (The question of osteochondritis dissecans of the patella.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1941, *63*, 176–180.

Osteochondritis dissecans most commonly involves the knee at the medial aspect of the internal femoral condyle. Involvement of the patella has apparently not been described in the literature. The author observed one case involving a question of compensation where there was a lesion in the central posterior area of the patella. The patient was a sixty-nine year old woman who injured her knee in a fall in January, 1938. It was somewhat painful, but no swelling appeared until a few weeks later. In July, 1939, an examination disclosed crepitus and some effusion. Roentgen studies revealed lipping on the tibial spine and an indistinctness in the outline of the patella with a loose bone fragment the size of a bean at the lateral aspect of the upper pole. In the oblique and lateral views made in July, 1940, another partially detached fragment was seen at the posterior surface. The first fragment was regarded as the result of a dissecting inflammatory process. The interval between the injury and the swelling seemed to exclude a traumatic basis and the appearance was not that of a bipartite patella inasmuch as the general contour of the patella was not maintained and the patella of the other knee was not bipartite. The conclusion is reached that the case represents an osteochondritis dissecans of the patella with detachment of two loose bodies and that the whole process is non-traumatic in character.—*W. A. Evans, Jr.*

KOHLBACH, WILM. Gasbildung im Gelenkspalt, ein röntgenologisches Distorsionszeichen. (Gas formation in the joint space, a roentgenological sign of distortion.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1941, *63*, 47–50.

It has been repeatedly demonstrated that the true capillary joint space between the articular cartilages may be seen as a narrow sickle-shaped, clear zone. This has been most often observed in the knee and shoulder joints. Various explanations have been given, such as an abnormal thickening of the articular cartilage, fatty infiltration of the synovia, enlargement of the joint space, or a particularly favorable projection of the ray, but none of these is without objection. The phenomenon has been observed in normal joints and in those subject to arthrosis deformans and ligamentous injury. The true explanation came from the systematic researches of Magnusson and later Nordheim, who showed that the space could be demonstrated, especially in children, by traction on the joint, i.e. by decreasing the internal pressure and releasing gas from the synovial fluid. Thus the observation of gas in a joint is always abnormal and indicates some distorsion. Six cases encountered in a short period by the author are reported. Five patients had experienced minor injuries to the shoulder and the roentgen examination a short time later revealed gas in the joint. Con-

trol studies a few days later in 3 cases showed a disappearance of the gas. Gas formation was also observed in the knee of a sixteen year old boy following a minor injury and this disappeared in a few days. As Nordheim has pointed out, the phenomenon will also disappear if an effusion occurs. In arthrosis deformans and old ligamentous injuries the irregularities of the cartilaginous surfaces and the weakness of the ligaments make it possible for even slight traction to reveal the true articular space.—*W. A. Evans, Jr.*

Fabiani, Fabio. Lussazione del ginocchio (tibia in dietro) da causa indiretta. (Luxation of the knee—tibia inward—from indirect causes.) *Radiol. med.*, Jan., 1941, *28*, 46–47.

A man was thrown into the sea by an explosion and when he reached land after swimming about 300 meters he found that the right leg no longer had its normal relation to the thigh but lay transversely across the knee of the opposite side. The leg was reduced to normal position and a plaster cast put on. After forty-eight hours when he reached a naval hospital the toes of the right foot were cold and insensitive. The plaster cast was taken off and the leg placed in a metal trough. Roentgen examination showed a luxation of the knee with the tibia turned inward. As the nervous and circulatory conditions of the leg did not improve, not even with the leg in flexion, the only position in which the luxation remained reduced, the thigh had to be amputated at the lower third.

The interest of the case lies in the fact that there was no sign of direct violence on the leg or thigh. The author believes that when the man was thrown into the water the right leg was caught temporarily in some way so as to cause a distorsion or subluxation of the knee, which in the effort of swimming to shore was aggravated until the luxation became complete.—*Audrey G. Morgan.*

GENERAL

Milani, Eugenio. Origine—sviluppo—avvenire dell'insegnamento universitario della radiologia. (Origin, development and future of the university teaching of radiology.) *Radiol. med.*, Feb., 1941, *28*, 65–77.

The author, who is the director of the Institute of Medical Radiology of the University of Rome, reviews the beginnings and progress of the university teaching of radiology in Italy, paying special tribute to Ghilarducci and Busi who were leaders in this work.

He points out the possibilities in the future development of this teaching, and shows that radiology must not be taught simply as a specialty in the narrow sense of the word but that it must be considered as a universal science and a cultural study of the greatest value. The student must learn not only the technique of making roentgenograms but he must be made thoroughly conversant with the fundamentals of radiology and must understand the new anatomy and the new physiology that have been created by the development of radiology and understand the possibility that roentgen and radium rays may even produce changes in the chromosomes such as to cause mutations in the race. The future development of this science offers almost unlimited possibilities for the advancement of medical and biological knowledge.—*Audrey G. Morgan.*

Bader, Ellis R. Sarcoid. *Radiology*, Oct., 1940, *35*, 482–485.

Sarcoid is a chronic infectious granuloma, the cause of which is unknown. Histologically it resembles tuberculosis but all tests for this disease, including animal inoculation, have proved negative. It has also been thought to be an atypical Hodgkin's disease.

Two cases, both in white males twenty years of age, are described and illustrated with roentgenograms and photomicrographs of the histological findings. They complained of enlarged glands and loss of weight. A gland excised from the groin and examined histologically was variously reported by different observers as endothelioma, tuberculosis, benign granuloma and sarcoid. Roentgen examination showed increased peribronchial tissue and floccular deposits in the lung tissue. One of the patients was followed up for two years and showed a rapid return to normal. The chest is not entirely clear but the patient is well clinically. In both cases diagnosis was based on biopsy findings, roentgenograms and clinical observation of the course of the disease.

In the discussion, Dr. Doub said that this disease was originally reported as a skin disease. When there are skin lesions they are in the form of small or large nodules or infiltration. If present they clinch the diagnosis in many cases. Many diseases have been considered the cause of this condition—even leprosy. Dr. Doub de-

scribed 2 cases in 1928 and had a letter from a man in South American saying they were not sarcoid but leprosy. The smears had been carefully examined for leprosy, however, with negative results. Darier-Roussy studied the tuberculous nature of the disease and while he could never demonstrate tubercle bacilli he did have positive results after several passages through animals. The disease may be caused by a filterable virus. As little is known about treatment as about etiology.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

CALDWELL, GUY A. Treatment of gas gangrene experimentally produced. *J. Bone & Joint Surg.*, Jan., 1941, *23*, 81–85.

Caldwell attempted to produce experimentally, in guinea pigs, the counterpart of a compound fracture infected with a lethal number of Welch's bacilli, and to treat these in some of the various ways suggested by clinical and laboratory observations.

Débridement of the wounds followed by implantation of 15 to 30 milligrams of sulfanilamide crystals and closure resulted in the survival of only 4 of 19 animals.

Débridement and irrigation of similar wounds left open, and followed by the administration of 50 milligrams of sulfanilamide intraperitoneally every six hours, resulted in the survival of 7 of 9 animals.

Débridement and irrigation of such wounds followed by implantation of zinc oxide paste and suture of the wounds resulted in the survival of 4 of 5 animals.

Wounds similarly produced and sutured and treated with roentgen rays in varying doses at different intervals were followed by death in 7 of 10 animals.

As far as can be determined by experiments in which a crude counterpart of a compound fracture infected with Welch's bacillus had been produced in the thighs of guinea pigs, Caldwell considered the following observations correct:

1. Sulfanilamide crystals implanted in such infected wounds after débridement seldom control or prevent the development of gas gangrene.

2. Administration of large doses of sulfanilamide by intraperitoneal injection after the wound has been debrided, irrigated, and left open precludes the development of gas gangrene in a high percentage of cases.

3. Implantation of zinc peroxide paste in debrided wounds prevents the development of gas gangrene in most instances.

4. Roentgen treatment has no effect upon the progress of a fulminating type of gas gangrene, but does bring about some localization of the process when given one to two hours after inoculation, and when the animals survive forty-eight hours or longer.

5. The bacteriostatic effect of sulfanilamide upon Welch's bacillus injected into the abdomen is not duplicated when the same organisms are planted in traumatized muscular tissue.

6. Further experiments should be carried out to confirm these conclusions, and others to ascertain whether combinations of zinc peroxide paste in the wound and sulfanilamide given orally or intraperitoneally may not be more effective than either of them alone.—*R. S. Bromer.*

MERRITT, E. A., and CAULK, RALPH M. X-ray therapy of hyperparathyroidism. *Radiology*, Oct., 1940, *35*, 477–481.

There are three forms of bone disease caused by hyperparathyroidism: cystic fibrous osteitis, the osteoporotic form with decalcification of the bones and the metastatic form in which calcium is deposited in the soft tissues, particularly the kidneys, in the form of calculi.

In this article the authors consider only the osteoporotic form in the spine. The patients have intense pain in the back, weakness and loss of weight. The blood picture is that of a secondary anemia. The spine shows demineralization of bone, collapse of the bodies of the vertebrae and the typical fish-tail appearance.There are varying degrees of kyphosis and scoliosis. The therapeutic test of irradiation of the parathyroids may be used in confirming the diagnosis.

Since 1932 the authors have treated 14 such cases by the following general method: 220 kv., 20 ma., 50 cm. focal-skin distance, 2 mm. copper filter and a field measuring 8×10 cm. over the front of the neck from the hyoid bone to the upper mediastinum. For the first series a total dose of 1,000 r, measured in air, is given in five to ten days. It may be necessary to repeat this series once or twice at six week intervals. The supplemental use of calcium and vitamins has proved of little value.

A case is reported in which the patient, a woman of sixty-five, was relieved of intense

pain and restored to normal weight and strength. Recalcification occurs slowly if at all and existing deformities are not corrected.

In the discussion Dr. Clark said he had a great deal of trouble in convincing clinicians that the pain and spinal deformities in such cases are caused by hyperparathyroidism. The relationship of cystic fibrous osteitis and some of the osteomalacias to hyperfunction of the parathyroids should be better known. Some forms of arthritis also seem to be caused by hyperparathyroidism. He described a case in a girl nine years of age who had a history of several fractures of the femur and multiple bone lesions elsewhere in the body. She was given roentgen treatment and has not had a fracture for five years.

Dr. Friedman said that the hyperfunctioning thyroid and pituitary are much more sensitive to irradiation than the normal glands. It would be interesting to find out whether this is also true of the parathyroids. Hyperparathyroidism has one constant finding—a high phosphatase content in the blood. This was not demonstrated in the case reported by Dr. Caulk nor was any roentgen evidence of healing after irradiation given. He doubts whether this case was one of hyperparathyroidism.

Dr. Norton asked what might be expected of roentgen treatment of urinary calculi caused by hyperparathyroidism.

Dr. Caulk, in closing, said he had had no experience in treating this form of kidney calculi. He said that unfortunately he had not been able to make determinations of phosphatase or blood calcium in his case but there are cases of cystic fibrous osteitis with normal blood calcium. The condition described in his case does exist, however, and it is known empirically that it can be relieved by roentgen treatment.—*Audrey G. Morgan.*

Sunderland, Douglas A., and Binkley, J. Samuel. The use of zinc peroxide in infected tumors and radiation necrosis. *Radiology*, Nov., 1940, *35*, 606–615.

The mouth contains many bacteria which under ordinary conditions are harmless saprophytes, but when the tissues are diseased they may cause serious infection. Zinc peroxide has been found useful in treating such infections occurring in ulcerated tumors or in post-irradiation or post-surgical infections. It releases oxygen slowly and is therefore useful in treating anaerobic infections.

The authors discuss 52 cases in which this method has been used. Seven of the cases are described in some detail. In some cases the good effects were strikingly sudden, in others slower. In all cases there was a rapid decrease of the disagreeable odor and in two or three days clean granulations appeared and the swelling and inflammation subsided.

The zinc peroxide is heated for four hours at 140° F. It remains active at least three weeks. When it is to be used the activated powder is mixed with water to form a suspension the thickness of 40 per cent cream. If the area to be treated is on the surface it is coated with the suspension and covered with gauze soaked in it, and sealed off with vaseline gauze or boric ointment strips. When it is used inside the mouth it is introduced into the lesion with a Kaufmann-Luer syringe and gauze packing or a sponge soaked in zinc peroxide suspension placed over it. Vaseline gauze is used to pack off the treated area. Ordinarily the dressings are left in place twenty-four hours if the type and location of the lesion make this possible.

Postoperative infections in non-irradiated tissue respond more readily than cases of radiation necrosis. The authors now use zinc peroxide as a prophylactic after operations inside the mouth.—*Audrey G. Morgan.*

Kaplan, Ira I. Radiation therapy of diphtheria carriers. *Radiology*, Oct., 1940, *35*, 425–429.

The treatment of diphtheria carriers has to be considered in the control of this disease. These individuals are immune but carry virulent bacilli. A carrier may be defined as a person who harbors virulent bacilli for a period of more than twenty-one days after his illness.

The New York Department of Health has found that the best way to treat these carriers is with roentgen irradiation: 180 to 200 kv., 0.5 mm. copper plus 1 mm. aluminum filter, 40 to 50 cm. distance, through fields 8 by 10 or 9 by 12 cm. in size. Both sides of the neck are treated the same day and the rays directed through the tonsils. The dose is 150 r per field per treatment, and three treatments are given one week apart. The treatment was immediately effective in 10 out of 11 cases treated and delayed relief was obtained in the other.

In the discussion Dr. Stevens said that they had little diphtheria in Detroit but he had seen

enough of the roentgen treatment of infections in general and diphtheria carriers in particular to warrant his endorsing this treatment for diphtheria carriers. The original successful work, however, was done with low voltage, 85 to 90 kv.

Dr. Bopp said that two points should be remembered in regard to the treatment of diphtheria carriers: first, that not all diphtheroid organisms are pathogenic and virulence tests should be made to determine whether the carriers need treatment, and second, that more than one culture is necessary to determine whether a carrier is free of diphtheroid bacilli. Generally three cultures are considered necessary. Few patients of this kind are seen at the Mayo Clinic. They have been treated with 135 kv., using the same general plan of treatment as that described by Dr. Kaplan.—*Audrey G. Morgan.*

PFAHLER, GEORGE E. Treatment of cancer of the lip and mouth. *Radiology*, Nov., 1940, *35*, 598–605.

In spite of the great progress that has been made in treating cancer of the lips and mouth the greatest hope lies in prevention. There are many precancerous lesions that can be recognized by the patient himself, such as erosion, fissure, papilloma, leukoplakia, swelling or induration, ulceration or a lump. Any person with such lesions should go at once to a physician, and general practitioners should learn to know the possibility of such lesions developing into cancer. Any fever blister that does not heal in two weeks should be examined by a physician skilled in the diagnosis of cancer. Every physician should examine the mouth of every one of his patients every time he sees them. An erosion may disappear after the application of silver nitrate; but silver nitrate if used too long may cause cancer and therefore it should not be used for more than two weeks. The more the early signs and symptoms of early cancer are talked about and emphasized the less late cancer there will be to treat. Many of these early lesions and even more advanced cancers of the lip can be removed successfully by electrosurgery. Very advanced cases can be treated by the surface application of radium. The author has had 98 per cent five year cures in lesions up to 1.5 cm. in diameter, 68 per cent in larger ones and 48 per cent in those with palpable lymph nodes. These are better results than can be obtained by block dissection. Moreover the fear of surgery is one of the things that keeps cancer patients from coming for treatment early.

Cancer of the mouth is always serious because metastasis is apt to occur early and may be extensive. Treatment is by irradiation, the technique depending on the size and location of the tumor. Not only the primary lesion but also the regional lymph nodes should be irradiated.—*Audrey G. Morgan.*

LYLE, FRANCIS M. Radiation treatment of ganglia of the wrist and hand. *J. Bone & Joint Surg.*, Jan., 1941, *23*, 162–163.

Ganglia occurring about the joints, and those involving tendon sheaths, are embarrassing deformities, and may cause pain and weakness of the joint. Some patients prefer prompt treatment. The ganglia may develop after injuries such as sprains, or insidiously without known trauma. Lyle treated 21 patients by radiation therapy and 6 of these have been followed for five years. All but two of the tumors were located in the wrist. The two exceptions were in the tendon sheaths of the thumb and first finger. Of the 21 patients, 18 complained of pain, 14 of the presence of the tumor, and 11 of weakness of the joint.

The size, duration and previous treatment of the tumor generally dictated the number of roentgen treatments required to relieve the symptoms. Eight patients received only one treatment; one received seven and another eight; the average number was nearly three. Of 8 patients who received one treatment, 5 were relieved of symptoms and 3 failed to return. Questionnaires answered stated that 1 of the 3 was not helped, but that the other 2 were slightly benefited by the treatment. Lyle gives the dosage as 1.5 erythemas immediately over the tumor. The patients were told to return in one month. If the tumor disappeared and all symptoms were relieved, one treatment was considered sufficient. While the tumor persisted 1.5 erythemas was given each month until results were obtained. He states that if more than five treatments are necessary, the interval between treatments must be more than one month. The tumor in the cases requiring seven and eight treatments gradually decreased in size, and increased in resistance to palpation. The actual process was one of fibrosis and destruction of endothelial secreting cells.

Seventeen, or 81 per cent, of the tumors dis-

appeared; 14, or 78 per cent, of those complaining of pain were relieved; and 9, or 82 per cent, of those complaining of weakness had normal return of function in the joint. In general, 17 had good results; 1 was improved, 2 were not improved, and 1 was not heard from.

Lyle believes that this method of treatment is superior to the various procedures used in the past and warrants a more extensive use. The advantages claimed for roentgen therapy over other procedures are: (1) a higher percentage of cures; (2) there is no resulting scar; (3) hospitalization is not required.—*R. S. Bromer.*

Halley, Edmund P., and Melnick, Perry J. Pre-operative irradiation in carcinoma of the breast. *Radiology*, Oct., 1940, *35*, 430–438.

Many clinical studies of carcinoma of the breast have been published but few histological studies. One school of writers has recommended a long interval between preoperative irradiation and operation, as long as two or three months, to allow of fibrosis and crushing of tumor cells by scar tissue. Another recommends a short preoperative irradiation period of ten days to two weeks, followed immediately by operation.

The authors have made a histological study of 21 cases of human cancer of the breast in which doses of 1,200 to 4,500 r were given over periods of from eleven to forty-nine days. They were operated on one to forty-five days after the end of irradiation. The findings in these cases are compared with those in 300 cases of transplantable rat tumor and photomicrographs of the comparative findings given.

They conclude from this work that the right interval between irradiation and operation lies between the extremes mentioned above. Fractional irradiation acts on human cancer of the breast in two ways. At first it produces a simple radionecrosis of sensitive cells and later from damage to their chromosomes the less sensitive cells form giant cells which fail to survive and often degenerate by calcification of their nuclei. Damage to the tumor bed and necrosis does not occur under the usual fractional irradiation.

Therefore the best procedure is to give irradiation for four or five weeks in order to reduce the viable tumor cells to a minimum. Surgery done within two or three weeks after irradiation has the advantage of working in such tissue. Healing is more rather than less prompt in irradiated patients. If operation is delayed for four weeks the cancer begins to proliferate again from the surviving tumor cells some of which remain in at least 90 per cent of irradiated breast cancers. Therefore as fractional irradiation does not cause obliteration of blood and lymph vessels, operation should be performed before such proliferation begins.

In the discussion Dr. Pfahler emphasized the great value of this histological work. He said, however, that the damage to the cancer cells occurs before it is visible microscopically and therefore he does not think it necessary to wait for more than a week after irradiation to operate. The dose he gives is between 900 and 1,200 r. That does not destroy cancer. It merely destroys the more sensitive, therefore the more malignant cells and the others, of Grade 1 or 2 malignancy may be removed by the surgeon. His five year recovery record with this method shows about 55 per cent recovery in cases with involvement of the axillary glands. That is about twice as high as can be obtained with surgery alone.—*Audrey G. Morgan.*

Watson, E. M., and Herger, C. C. Carcinoma of the bladder; correlation of the pathological and clinical data as a basis for treatment. *J. Urol.*, March, 1941, *45*, 331–336.

Four hundred and forty-five cases of primary epithelial tumors of the bladder form the basis for this study. They were divided into three groups histologically: papillary carcinoma, non-infiltrating; papillary carcinoma, infiltrating; and non-papillary solid infiltrating carcinoma.

One hundred and three cases came under the heading "papillary carcinoma, non-infiltrating." The sessile and pedunculated forms were encountered. Recurrence was common after apparent destruction. Single small lesions were treated with transvesical electrocoagulation. Multiple or large single tumors were treated with 200 kv. deep therapy, externally; two to four fields were used, daily doses ranging from 125 to 400 r as measured with backscatter. When 125 r per field was used 3,000 to 5,000 r total was administered to each field. When 400 r daily dosage was applied the total dosage to each field was limited to 2,800 r. The former treatment stretched out over two to three months and was only used where the entire bladder was filled with multiple papillary growths of low malignancy. External treatment was not pushed to the point of complete disappearance of the growth since this would result in

irreparable damage to the normal structures. However, there was usually sufficient regression to permit transurethral coagulation. Radium implants were used only with great caution because of fear of radium ulcers.

One hundred and sixty-nine cases fell in the group labelled "papillary carcinoma, infiltrating." Single small lesions were treated by coagulation and radon implantation. In large lesions the McCarthy electrotome and radon implantation of the base were used. When too large for transurethral treatment a preliminary course of external irradiation was used before coagulation. External irradiation was not as effective in the infiltrating type of tumor and interstitial irradiation was required.

One hundred and three cases were classified as "non-papillary solid infiltrating carcinoma." These tumors showed a tendency to epithelial pearl formation and were usually single. External irradiation was almost without value in this class, except for the control of hemorrhage. Transurethral radon implants were used in the smaller tumors. In the larger tumors widespread infiltration of the bladder wall was usually present and the tumor occurred on the floor of the bladder where segmental resection was not possible. In the female, radium element needles introduced through the anterior vaginal wall produced good results. Four to five needles with 0.6 mm. platinum filtration, and containing 3 mg. of element each, were introduced at 1 cm. intervals and left in situ for six to seven days. This gave a dose of 2,000 mg-hr.

In 179 cases of the papillary type treated prior to 1936 a 28 per cent five year survival was obtained. In the solid tumors a 12 per cent five year survival was obtained. In the papillary cases treated subsequent to 1935 disappearance of the tumor has occurred in 43 per cent of the cases for one to four year periods.—*R. M. Harvey.*

COLBY, F. H. Evaluation of the supervoltage treatment of bladder tumors. *J. Urol.*, March, 1941, *45*, 337–341.

Because of high intensity with his million volt roentgen unit the author has been able to use a long target-skin distance and obtain a depth dose of 50 per cent in the center of the average sized pelvis. Scattered radiation is reduced by using smaller portals. The average wave length of radiation obtained was similar to that obtained from radium filtered with 2 mm. of lead. Skin reaction is no longer the limiting factor in treatment but bladder and intestinal tolerance. The author's present technique is to deliver 7,000 to 8,000 r with a daily dose of 400 r to each of three pelvic portals, 12 by 12 cm., anterior, posterior left oblique, and posterior right oblique. An additional 3,000 r may be given three weeks later if cystoscopy shows tumor regression. Individual tolerance, tumor regression, and biopsy reports govern further treatment.

This treatment is well tolerated. Roentgen sickness rarely occurs, bladder and rectal symptoms are common but not serious. Only tumors too extensive for surgical removal were treated. The best response was obtained in epithelial tumors with rapidly growing undifferentiated cells. In 50 per cent of cases treated with supervoltage radiation marked regression of the tumor took place. In one-third of the cases the tumor apparently disappeared.

In the author's experience response was much better to supervoltage irradiation than with lower voltages. Tumors which have disappeared grossly frequently recurred. Recurrences are more resistant to treatment. Results do not justify the belief that this treatment is curative.—*R. M. Harvey.*

NAEGELI, F. D. Epithelioma of the penis. *J. Urol.*, Feb., 1941, *45*, 202–215.

Carcinoma of the penis is said to constitute 2 per cent of all carcinomas in the male. The most important single cause is balanitis. Circumcision of male infants is a valuable prophylactic measure, since the disease is rarely found in the circumcised. Leukoplakia, chronic irritation, venereal diseases and trauma are other causes. The age incidence is the same as in other cancers.

Histologically the papillary and infiltrating types are found. The former is the commonest type and originates on the glans. They are usually highly malignant. Metastatic sites are the superficial and deep inguinal nodes, the external iliac nodes in the pelvis, and the liver. Only 50 per cent of palpable glands are malignant, which is of importance for the question of node dissection. Symptoms include preputial drainage, pain and itching, bleeding, urinary obstruction and glandular enlargements. The diagnosis should not be difficult and in doubtful cases may be confirmed by aspiration biopsy.

Treatment includes surgery, electrosurgery and radiotherapy. Plastic penile amputation is

advocated with block dissection of malignant nodes at a later date, when the possibility of inflammation has been ruled out by increasing size and failure of regression. Such a conservative plan reduces the mortality markedly. Pfahler, Widmann and others recommend electrocoagulation of the primary lesion. In small lesions the Memorial Hospital uses radon plaques filtered with gold in 2 mm. brass capsules for a dosage of 1,400 mc-hr. per sq. cm. Roentgen therapy appears ineffective for the following reasons: radioresistance of the tumor, complicating infection, poor tolerance of radiation by the moist skin and resistant fat depots around the nodes.

The poor results in this carcinoma are due to delay in seeking treatment, the average interval being fourteen months. In the author's series of 28 cases there was an 18 per cent three year survival.—*R. M. Harvey.*

MISCELLANEOUS

Gilardoni, Arturo. Accorgimenti e osservazioni pratiche per ottenere dei buoni radiogrammi. (Technical details and practical suggestions for obtaining good roentgenograms.) *Radiol. med.*, Feb., 1941, *28*, 99–108.

The author holds that the majority of failures to obtain good roentgenograms are not due to poor function of the apparatus used but to incorrect photographic methods. He thinks that 90 per cent of the failures are due to overexposure from too high tension or underdevelopment. In case of failure another attempt should be made, decreasing tension by 10 kilovolts and using a fresh and warm developer and prolonging the time of immersion in the bath.

Two tables are given showing exposure times for different parts of the body in individuals of average weight, height and thickness of the parts. One of them is valid for high-power apparatus with highly charged tubes and the other for low-power apparatus and tubes with a low charge. With increasing thickness of the parts an average increase of 2.5 kv. is necessary for every increase in thickness of 1 cm. An increase of 10 kv. in pressure reduces the exposure time by about half, and vice versa. The use of an antidiffusor diaphragm necessitates an increase of the exposure time by about two and a half times or an increase of 15 kv. Roentgenograms of parts in plaster require about three times as many milliamperes as those without plaster.

It is generally given as a rule that roentgenograms should be developed for about five minutes. This is true only on the use of a concentrated developing solution at a temperature of 18°. The developing solution rapidly loses its freshness and after a few days the time for development at 18° is prolonged to eight or nine minutes. The author thinks it better to use the solution at 22° so that the developing time will come within five minutes.—*Audrey G. Morgan.*

Drea, W. F. The attenuation by x-rays of human tubercle bacilli. *Am. Rev. Tuberc.*, April, 1940, *41*, 507–511.

In 1938, Drea reported evidence of attenuation of tubercle bacilli after subjecting them to prolonged roentgen irradiation—336 to 1,092 hours, with the delivery of 628,992 to 2,044,224 roentgens. His studies provoked some doubt as to whether the irradiation was directly responsible. It seemed possible that the attenuation might have been due to ageing of the strain or to changes in the culture medium due to the irradiation.

This particular study was directed toward satisfying these two doubts. One culture of organisms was irradiated for thirty-six hours, giving 60,480 r over a period of four days. Colonies were transplanted three successive times and from the third transplant, guinea pigs were inoculated. A control culture was handled in like manner, except that it received roentgen irradiation. A second control was performed as far as the culture medium was concerned; the inoculations and transplants being made on irradiated medium (treated with a total of 561,600 r).

The survival period for the guinea pigs which had been inoculated with the irradiated bacilli averaged 95.5 days; that for the control group, 65.6 days. Both of these groups showed lesions in the spleen, liver and lungs. There was no evidence of attenuation of the organisms grown on the irradiated culture medium. Thus it appeared that the attenuation comes about as a result of the direct action of the roentgen rays upon the bacilli.—*A. A. de Lorimier.*

Ellinger, Friedrich. The goldfish as a new biologic test object in experimental radiation therapy. *Radiology*, Nov., 1940, *35*, 563–574.

Physical doses must be correlated with biologic effects in experimental radiation therapy. As depth dose measurements are commonly made in a water phantom tests were made of

the suitability of goldfish as biologic objects. A water phantom 32×32×32 cm. was used and in one set of experiments the goldfish in Petri dishes were irradiated at the surface and in another at varying depths. Treatment was given with 200 kv., 30 ma. with a distance of 50 cm. from the target to the surface of the water and the field size 15×15 cm. For the surface experiments the half-value layer was 6 mm. aluminum, corresponding to 0.233 mm. copper, intensity 230-172 r/min.; for the depth experiments filter 0.5 mm. copper and 1 mm. aluminum, half-value layer 1 mm. copper, intensity 48 r/min. Graphs are given showing the lethal effects of different doses and the constancy of the lethal effect under different conditions, also the depth dose at 10 cm.

The goldfish seem to be an ideal test object as they are available at all times and easy to care for. Their radiosensitiveness is very nearly the same as that of mammals. Different stages of the reaction can be read accurately and without difficulty. After the irradiation the fish were placed in aquaria and kept under observation. Many fish can be irradiated at the same time; their radiosensitiveness remains approximately the same the year round. The size of the goldfish—within reasonable limits—does not influence the effect of the radiation. Biologic objects should not replace ionization measurements but the results of the two should be correlated. This is particularly true since the use of high voltage therapy has shown some discrepancy between the results of biologic tests and those of ionization measurements.—*Audrey G. Morgan.*

COHEN, IRVING. Cleavage delay in Arbacia punctulata eggs irradiated while closely packed in capillary tubes. *Radiology*, Nov., 1940, *35*, 561–562.

It was shown some years ago that roentgen irradiation of *Arbacia punctulata* eggs before fertilization causes a delay in cleavage. It was suggested to the author that if the eggs were irradiated while closely packed in capillary tubes by centrifuging the delay produced by a given dose would be less than if they were irradiated in large amounts of sea water. His experimental results show that this is true.

The technique of the experiments is described and the possible causes of this difference discussed. They are theoretical as yet. But whatever the explanation of the results they show that radiosensitiveness is dependent on the environment of the cells.—*Audrey G. Morgan.*

CHARLTON, E. E., WESTENDORP, W. F., DEMPSTER, L. E., and HOTALING, G. A million-volt x-ray unit. *Radiology*, Nov., 1940, *35*, 585–597.

A new million-volt unit is described which contains a low frequency resonance transformer with a coaxially mounted multisection roentgen tube within. The transformer and the tube are mounted in a grounded steel tank and compressed gas is used for insulation. The roentgen rays are produced from a tungsten target mounted in the end of an extension chamber projecting out from the bottom of the grounded tank. This new one million volt unit is very compact, easy to operate, reliable, entirely free from exposed high voltage and has a readily accessible roentgen-ray target. It is described in detail and illustrated with photographs and a cross section drawing and circuit diagram.

In the discussion Dr. Marinelli described the layout of the unit in the Memorial Hospital, New York, and the measures used for protecting the operating personnel and the setting up of the patient in the most comfortable way for treatment.

Dr. Newell asked whether two other types of power plants might not be possible: one a perfectly standard transformer in chain connection such as are provided for testing sets in various places and the other a Van de Graaf electrostatic generator to operate the same tube.

In closing, Dr. Charlton discussed the economics of the plants proposed by Dr. Newell and concluded that the resonance transformer roentgen-ray unit seemed to offer the greatest possibilities of economy.—*Audrey G. Morgan.*

NEWELL, R. R. Quality of roentgen rays: effect on tissue dose, and clinical importance. *Radiology*, Oct., 1940, *35*, 402–406.

The author discusses theoretical considerations in regard to the effects of different qualities of rays. In his own clinical experience he has used only three qualities, that is rays with a half-value layer of 1 or 2 mm. aluminum, 0.8 mm. copper and 5 mm. copper. On the whole, he has been struck by the fact that all these qualities produce such remarkably similar effects. It seems more and more probable that the different reactions seen are due not so much to spe-

cific biologic effects of the different qualities of rays as to the different ways in which they are used. The rate of application, the degree of protraction (fractionating), size of fields and methods of cross-fire all affect the results.

There is one instance, however, in which he has seen decidedly superior effects from supervoltage. Cross-firing the pelvis and using a half-value layer of 5 mm. copper he has had reactions in the vagina and cervix that he has never had with a half-value layer of 1 mm. copper. To bring about these effects he has used narrower beams and oblique cross-fire that he thinks would have been ineffective with softer rays.—*Audrey G. Morgan.*

Busanovich, G. M. The calibration of x-ray developer. *Radiology*, Oct., 1940, *35*, 407–412.

As the chemicals in a developing solution become exhausted the development time must be lengthened at certain intervals to compensate for this loss. In any photographic work some account is generally taken of the effect of development time on density but the effect on contrast is usually disregarded. In this article a method of exact calibration of roentgen-ray developer is described, that is a method of accurate measurement of its effect on exposed film. Roentgen film is exposed under an aluminum stepladder and the strips of exposed film developed at regular intervals. The strips of aluminum begin at 1 mm. in thickness and increase to 6 mm. With tanks of 10 gallon capacity or larger the test strips are developed at intervals spaced by the development of 50 large films or their equivalent.

Standard calibration curves are worked out on graphs which show for a 17½ gallon tank the number of films or the total film area developed and the increased development time necessitated by such use of the solution. One calibration is not enough for the exact prediction of the proper development time at any given interval. At least three should be taken under the same conditions and the average of the three considered a standard calibration curve. These curves may be drawn on graph paper and hung in the darkroom. The technician then has only to keep count of the number of films developed and refer to the curves to determine the correct development time.—*Audrey G. Morgan.*

Kaufman, Julius. Graphic constructions for localization, mensuration and reduction: standard symbols and nomenclature. *Radiology*, Oct., 1940, *35*, 489–492.

Figures are given showing the standard symbols and nomenclature and the basic constructions advocated. The latter include depth determination by standard depth curve and by depth localization triangle, line reduction by reduction triangle, plane reduction by radial reduction and by perimetric reduction, projection determination by vector image intersection, by the offset method and by the vector image reduction method and mensuration by space construction. A study of the figures would be necessary for a clear understanding of the subject.

The acceptance of these symbols, nomenclature and constructions would greatly simplify the reading and writing of treatises on localization and mensuration. A hypothetical case is given in which the whole procedure is described simply and directly without a single drawing or illustration.—*Audrey G. Morgan.*

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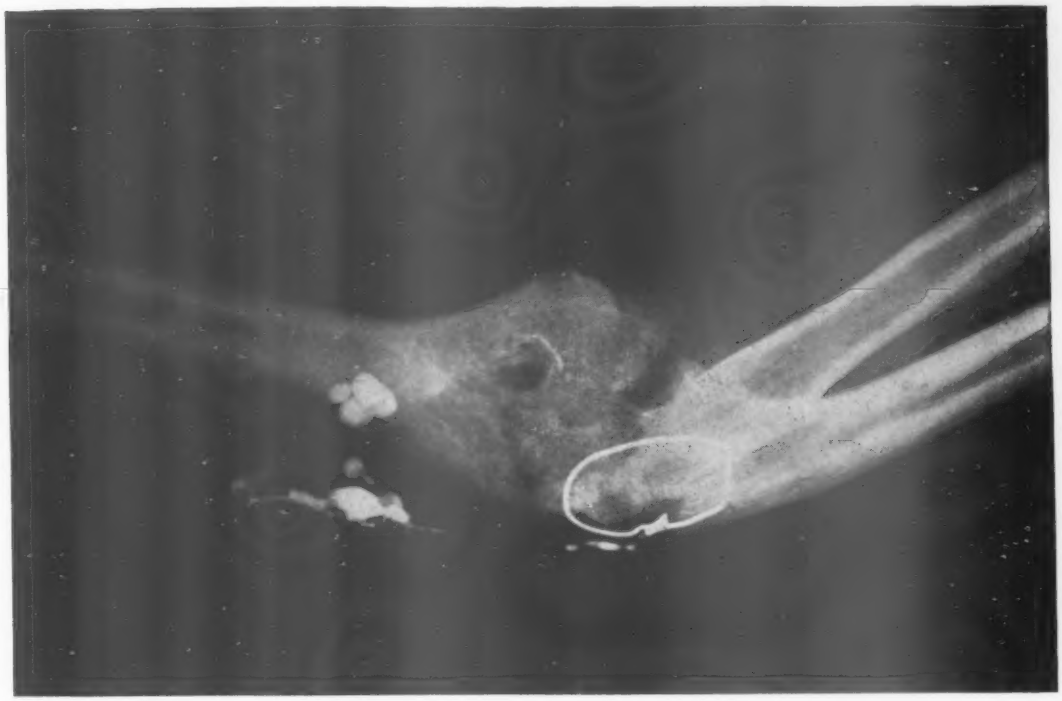

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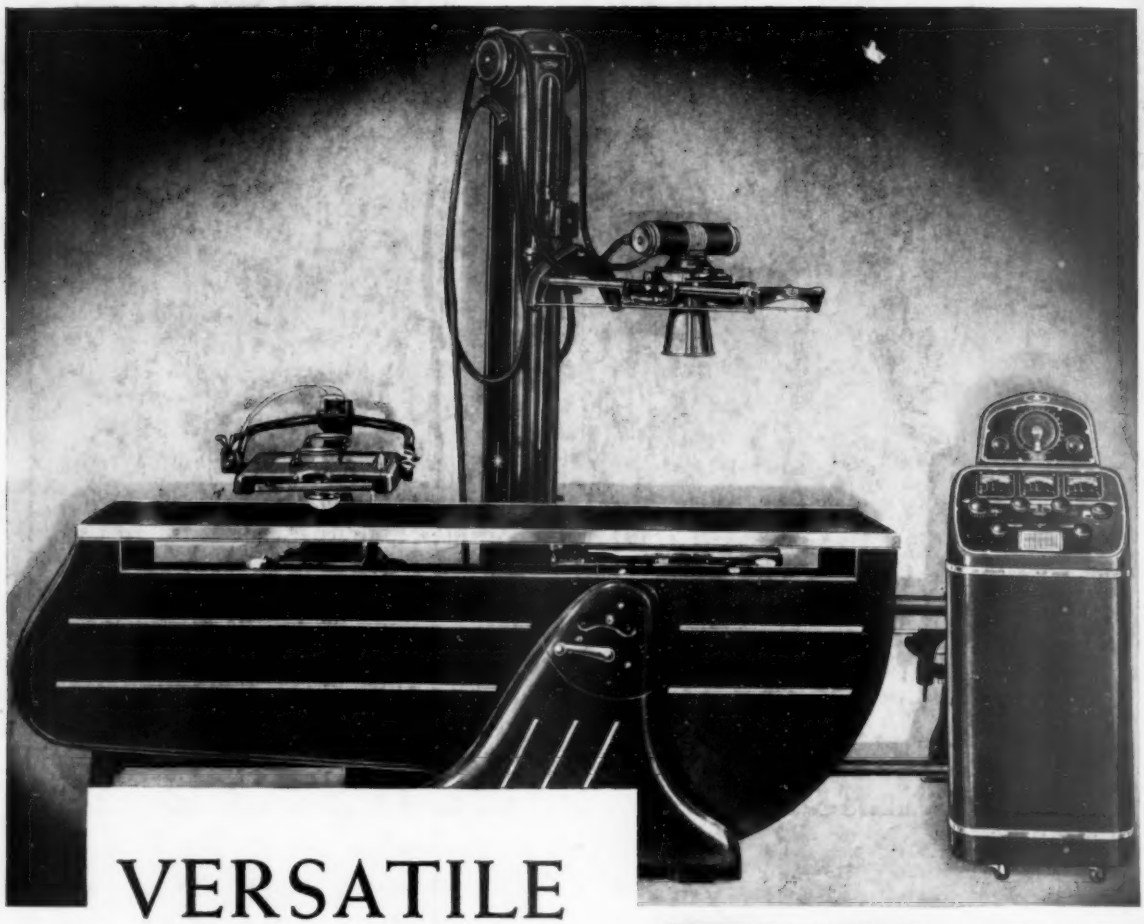

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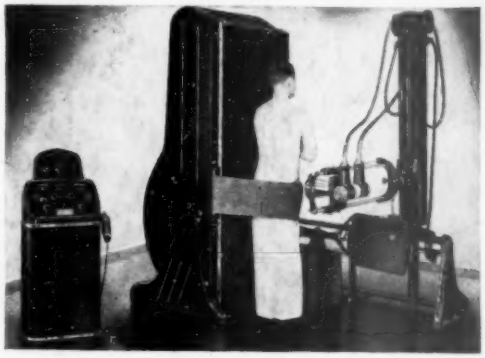

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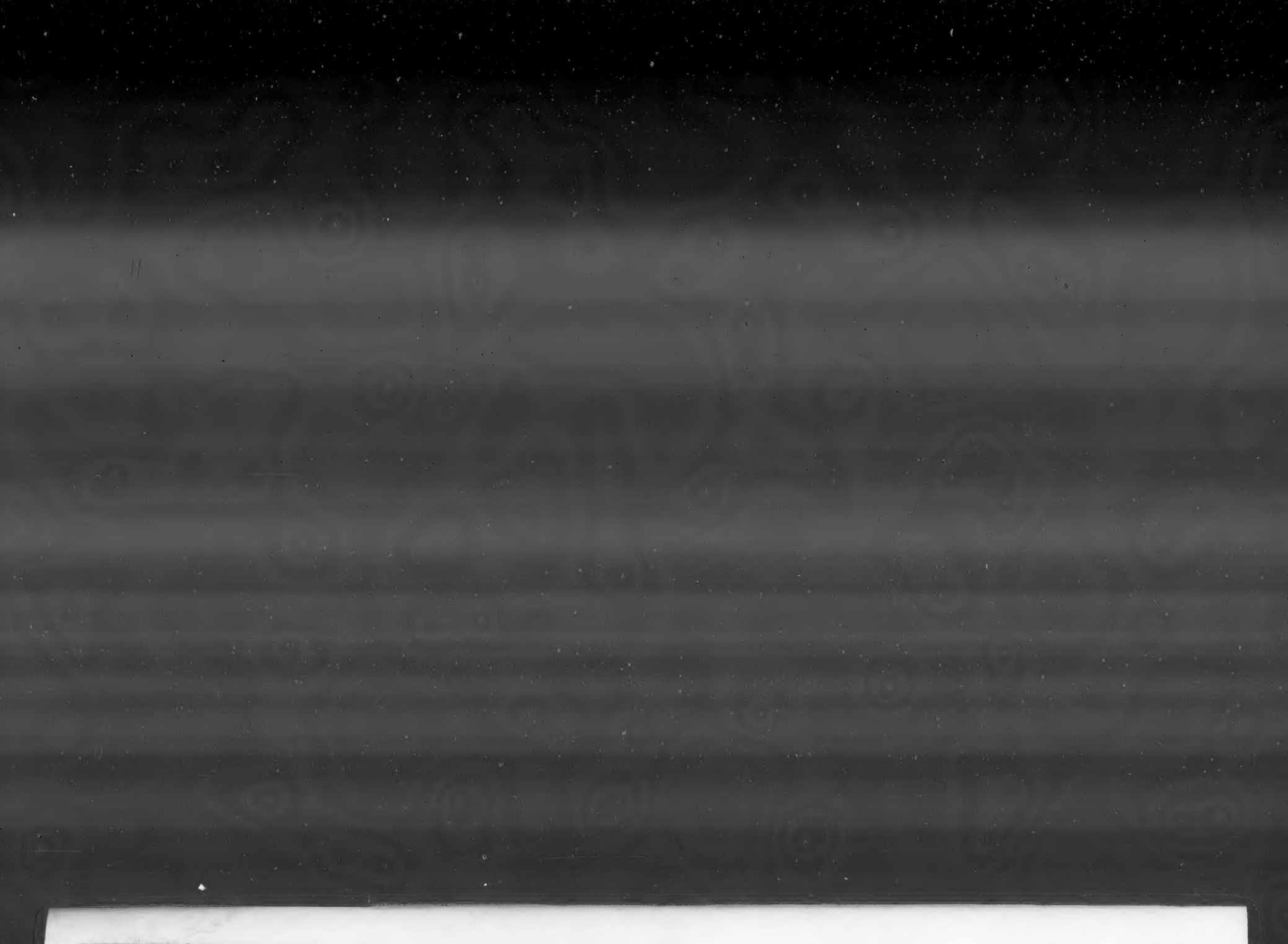
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